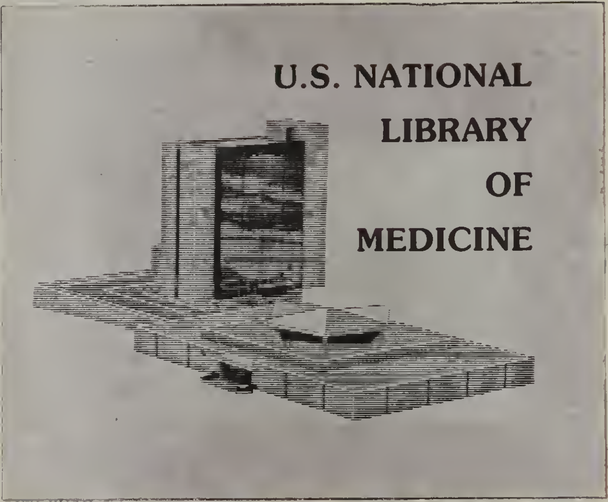
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FIRST AID

IN

ILLNESS AND INJURY

COMPRISED IN A SERIES OF CHAPTERS ON

THE HUMAN MACHINE

ITS STRUCTURE, ITS IMPLEMENTS OF REPAIR, AND THE ACCIDENTS AND EMERGENCIES TO WHICH IT IS LIABLE

BY

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PREFATORY NOTE

THE importance of a general knowledge of the steps to be taken immediately in order to prevent serious consequences from accident or injury is now everywhere recognized. In the preparation of this contribution to the literature of the subject, three objects have been kept in view: 1. To strip the subject as far as possible of technicality. 2. To avoid dwelling upon procedures requiring medical experience for their application. 3. To make a distinction between essential points and details, which, while valuable, might be omitted without damage — accomplishing this by stating the important facts in large and the accessory points in small type.

While it has been the author's aim to produce a text-book for civilian and military first-aid classes, he has also sought to provide a manual for quick reference in the emergencies, which arise not only before the soldier on detached service, the explorer or hunter in sparsely peopled districts, and the dweller at a distance from medical service, but in the quiet household, the crowded factory, the overflowing streets, and everywhere that work is done and lives are lived; for wherever humanity exists, the means of learning how to stay the arrival of impending death and how to afford relief to the suffering cannot fail to be of advantage.

In the effort to cover the ground as completely as possible, all available works bearing upon the subject have been examined with great care. While it is impracticable to acknowledge in detail the assistance derived from so many sources — save, perhaps, *Holden's Osteology*, *Esmarch's Surgeon's Handbook*, and the *U. S. Army Manual of Drill for the Hospital Corps*, which is reprinted entire, with original illustrations, in connection with carrying the disabled — the author gladly takes this opportunity of acknowledging in general his indebtedness to his many co-workers in teaching early aid in illness and injury, whose writings have been both suggestive and inspiring to him.

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Part I

THE CONSTRUCTION OF THE HUMAN MACHINE

Part I

THE CONSTRUCTION OF THE HUMAN MACHINE

The body of man is a machine of most complicated structure, containing thousands of distinct pieces and many different varieties of materials. For practical purposes it may be considered in eleven groups, it being understood that it is designed not to give a complete account of them, but merely to convey such a general idea of the various parts as may be requisite for understanding the means of staying danger from the emergencies of illness and injury. The eleven groups are:

1. The Covering — the skin.
2. The Padding — the fat.
3. The Framework — the bones.
4. The Hinges — the joints.
5. The Moving Apparatus — the muscles.
6. The Central Power — the brain and nerves.
7. The Repair Apparatus — the blood-vessels.
8. The Speaking and Breathing Apparatus — the larynx and lungs.
9. The Digestive Apparatus — the stomach and bowels.
10. The Waste Removers — the excretory apparatus.
11. The Perceptive Apparatus — the senses.

CHAPTER I

THE COVERING—THE SKIN

THE first structure forms a covering for all the others. It may be compared with the sacking of which a bag is composed, which covers and protects the articles stored within it. As a rip or tear in the sacking exposes the contents of the bag to damage, so a cut or laceration of the skin subjects the structures underlying it to injury. In it terminate many of the nerves of sensation, and it is therefore a very important organ of touch. It is, moreover, a very efficient organ of excretion of fluid and gaseous waste products, throwing off under ordinary circumstances as much as two and a half pounds of fluid during a day. Those of its functions then which come under our observation are (1) enclosure of contained parts, (2) protection of subjacent organs, (3) the location of the sense of touch, and (4) excretion of certain waste products.

The skin, simple though it seems to be, is a very complicated structure, and not only contains many forms of the elements composing it but presents in its substance a number of organs of great importance to the maintenance of life and health. It is ordinarily considered in three layers, (1) the epidermis or cuticle, (2) the dermis or cutis, and (3) the subcutaneous cellular tissue.

The **epidermis** or "*scarf-skin*" consists of successive layers of scaly particles, which are flattened and dried cells. These cells are technically known as epithelium. They cover all surfaces of the body, both external and internal, lining alike the skin, mucous membrane, and serous membrane, and are of varying shapes. At some points, but a single layer of epithelial cells is found, while others present many. The number of cells may also be abnormally increased as in the callous spots on the hands of men engaged in heavy manual labor, or in warts which are local overgrowths of the epithelium forming the epidermis. The epidermis is well shown in a blister where it is elevated by a watery effusion.

The **dermis** or "*true skin*" is a tissue composed of closely interwoven strong fibres with an admixture of elastic fibres, containing in its meshes many vessels, nerves, and minute glands. Blood-vessels are very abundant here, and hemorrhage results from the slightest incision. Here also lie the ends of the nerves from which is derived the sense of touch.

The **subcutaneous cellular tissue**, from its close relation to the skin, may properly be considered as a part of it; its composition is practically the same, the apparent difference being caused by the loose manner in which the fibrous material is interwoven into a more open fabric. Enclosed in its meshes and spaces are found the origins of many of the appendages of the skin, together with numerous masses of fat.

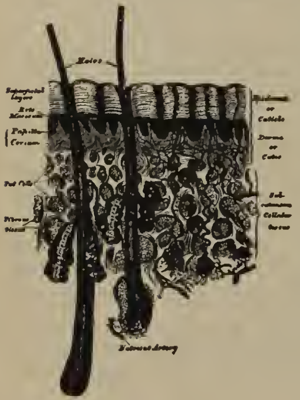

Fig. I. — Section of skin, showing its layers and the origin of its appendages.

The **appendages of the skin** are of two kinds, — modifications of the epidermis, and excretory glands. The hair and nails are, like warts and callosities, a local overgrowth of the epidermic epithelium, differing from them, however, in not being abnormal and performing certain functions.

The sweat and sebaceous glands are organs of excretion located in the subcutaneous cellular tissue, and opening externally by microscopic twisted ducts passing through both the dermis and the epidermis. The former are the source of perspiration, while the latter produce a yellow unctuous matter somewhat resembling suet, the function of which is the lubrication of the surface of the body.

When this sebaceous matter collects and hardens in the unclosed ducts, forming a sort of plug, the external end of which is black, we have the "black heads," "worms," or "grubs," very commonly seen in the skin of the face. These plugs of sebaceous matter, which assume, when squeezed out, a worm-like form, with a head formed by the outer end blackened probably by dust — are not infrequently supposed by the ignorant to be actual worms.

If, however, the external orifice of the duct be closed by any accident, the sebaceous matter continues to collect behind the obstruction, distending the duct in all directions until a tumor known as a wen, sometimes of considerable size, is formed. They are quite frequently

found in the scalp, where they produce a peculiar knobby appearance.

The excretion of waste products, particularly by the sweat glands, is essential to life, and its diminution produces poisoning of the system, as is seen in the dry skin of fevers, while its entire cessation would produce early death.

CHAPTER II

THE PADDING — THE FAT

In packing into the same receptacle articles of various shapes and sizes, some tender like ripe fruit, and others hard and stiff like blocks of wood, some sort of padding or filling is necessary to prevent mutual injury. This function is performed in the bodies of man and animals by the fat which fills in the interstices between the various parts.

In addition to this. the fat serves as a reserve of nourishment upon which the system may draw in case of lack of ordinary means of nutrition. This function is familiar in cases of illness; when the appetite is poor and but little food is absorbed into the system, the sick one grows thin because the small quantity of food taken is not sufficient to sustain him, and he is compelled to draw upon the reserve of fat stored up in the interstices of his system.

Perhaps the most important function of the fat, however, is the maintenance and retention of the animal heat. Every one has observed that a stout person requires less clothing than a thin one, and this is due to the greater amount of fat underlying his skin.

While this constituent has its advantages, it may also be the source of no little inconvenience in certain cases: it may choke up certain organs so as to interfere with their action, and, by mingling with the tissues of other organs, render them weak and inefficient; it may also obscure adjacent tissues, as is seen in the case of a wounded artery in a stout person, where the fat renders it difficult to find the bleeding

vessel above the wound and interferes with proper compression when it is found.

There are three principal fats in the body, — stearin, palmitin, and olein. These all consist of glycerine, which is an alcohol, in combination with a fatty acid, stearic, palmitic, or oleic, as the case may be. In the manufacture of soap, these acids set free the glycerinc and combine instead with an alkali.

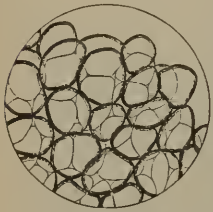

Fig. 2. — Adipose tissue magnified.

Fat is ordinarily seen in the form of **adipose tissue**, which is formed by masses of minute vesicles consisting of an exceedingly delicate membrane filled with fatty matter and having an average diameter of $\frac{1}{500}$ of an inch. These vesicles are grouped together and retained in place mainly by microscopic blood-vessels. The amount of adipose tissue in the body is subject to great variations according to its location, being entirely absent, for instance, in the brain and in the eyelids, while it is present in great abundance about the kidneys and other parts of the abdomen.

CHAPTER III

THE FRAMEWORK — THE BONES

THE bones form the framework about which are grouped the soft parts of which the body is otherwise composed. They also are designed for the protection of vital centres, as the brain is protected by the skull, and the heart and lungs are guarded from injury by the thorax. They consist of a hard, brittle substance, liable to become broken by sudden severe violence, but of sufficient strength to sustain any strain that may ordinarily be applied to them.

Bones are composed of *one-third animal matter*, principally gelatin and blood-vessels, and *two-thirds mineral matter*, carbonate, phosphate, and fluoride of lime, soda, common salt, and phosphate of magnesia.

The mineral constituents of bone may be dissolved by chemical action, leaving behind only the gelatinous animal matter while still re-

taining the original shape and dimensions of the bone. It may then be bent freely in all directions, and it is a common class-room experiment to tie into a knot a long bone so prepared. Similarly, the animal matter may be extracted by calcining or burning the bone. The proportion of animal to mineral matter is constant in the bones of the dead as well as the living, and it was this characteristic which enabled Gimbernat to make soup from a mastodon's tooth, and Buckland to obtain the body of a broth from fossil hyæna bones.

Fig. 3. — Bone, from which all mineral matter has been removed, tied in a knot.

The presence of animal matter contributes to the toughness and elasticity of bone. In children this is particularly apparent — the latter quality rendering fractures far less frequent in proportion to the frequency of accidents, while the former accounts for the frequency of a mere bend in a child's bone where that of an adult would be broken. This characteristic is very notable in some of the lower animals. Arab children are said to make excellent bows of the ribs of camels, while the elasticity of the clavicle or "wish-bone" of fowls is familiar to every one.

Microscopically, bone consists of concentric layers called **lamellæ,** arranged about the course of a vascular or **Haversian canal.** Throughout these lamellæ are minute cavities called **lacunæ,** each containing a bone cell or *osteoblast,* which influences the nutritive processes going on in the neighboring bone; and diverging from these cavities in every direction are minute canals or **canaliculi,** by which the lacunæ are connected with one another and with the Haversian canals, providing free intercommunication throughout the bone substance for blood and lymphatic vessels.

Fig. 4. — The structure of bone magnified.

These elements unite to form two kinds of bone substance, — the ivory-like *compact substance* seen for instance in the shaft of a long bone, and the spongy *cancellous substance* seen in its extremities.

Both the structure and composition of bone are so arranged as to endue it with great strength, particularly remarkable as compared with

other substances. It has nearly four times the resisting power of lead and three times that of ash wood. A cubic inch of bone will support 5000 pounds' weight. Moreover, the structure of bone is such as to give it this strength with but little expenditure of materials.

Bones are covered externally by the **periosteum,** a fibrous membrane in which run many blood-vessels, branching in all directions and supplying nutriment to the bone. Cavities in bone are similarly lined with a delicate membrane, the **endosteum,** and filled with *marrow.* Both the periosteum and the endosteum contain many bone-forming cells, and fulfil a very important function in the formation, repair, and reproduction of bone.

The bones in the human body are two hundred in number, not counting the teeth and the small bones in the ears and in certain of the tendons. Taken together they constitute the **skeleton,** which weighs from twelve to fourteen pounds, the right side usually being a little heavier than the left. The points where the bones are joined to one another are called **joints**, and at these points a certain amount of motion is invariably present, varying in extent from the extreme degree permitted at the shoulder to the almost imperceptible amount present in the pelvis. To this provision of the economy is due the ability to perform most of the functions of life. The condition of an individual with immovable joints, making the skeleton practically a single bone, would be deplorable in the extreme. He might live by the use of liquid food, but he could neither chew nor talk. He could not stand, because a certain amount of joint motion is necessary for the maintenance of an erect posture. Continued disuse would cause his muscles to waste away, and he would be compelled to drag out a miserable existence, looking forward to death as a bearer of freedom to his imprisoned life.

Bones are classed as long, short, flat, and irregular. A glance at the skeleton will emphasize the correctness of this classification. The bones of the arms and legs will readily be recognized as *long bones*. In the wrist and about the heel will be seen *short bones*. The shoulder-blade and the bones of the cranium are *flat bones*; while those composing the spinal column are distinctly *irregular bones*.

The long bones serve as supports and levers for locomotion and lifting. They consist of a shaft, or body, and two extremities, articulating,

or forming joints, with neighboring bones, and for this reason called articular extremities. In addition, they present various projections, called processes, which, it should be remarked, are found in most other bones; they are mostly designed to afford additional surface for the attachment of muscles.

The short bones are situated at points where strength and limited motion is desired.

The flat bones are designed to protect important viscera, such as the brain, or to afford extensive surfaces for the attachment of muscles.

In addition to the bones which are invariably present in the skeleton, are certain adventitious bones called **Wormian bones** and sesamoid bones. The former are irregular bits of bone, developed at points of the skull covered in infancy by membrane, the **fontanelles,** or "soft spots." **Sesamoid bones** are developed in the course of tendons, and contribute additional leverage to the muscles which terminate in these tendons. They are found in the tendons of the hand and foot. The patella, or "knee cap," is, in fact, a sesamoid bone, although, on account of its size, it is usually considered as a part of the skeleton proper.

In the development of the body from the ovum, the first trace of the future skeleton, and almost the first evidence of the future individual, is a minute cellular cord called the **notochord** or **corda dorsalis**. The notochord occupies the place in which from this time the spine or vertebral column begins to be formed. Here appear ultimately the skull and the twenty-six bones forming the spinal column.

The skull is the upper expansion of the spinal column. Its analogy to other parts of the spinal column may be very clearly traced. It is designed primarily to contain and protect the brain, and its structure is marvellously adapted to these purposes. The skull is properly considered in two parts, the **cranium,** or brain-case, formed by eight bones, and the **face,** formed by fourteen bones, making a total of twenty-two bones, or a little more than one-tenth the number in the whole body.

The **cranium** is a dome-like structure, the arching roof of which is so arranged as to decompose and disperse forces striking upon it, thus preventing their action upon the delicate brain substance contained in it. Were it not for this fortunate provision, injuries to the brain would occur much more frequently than they do.

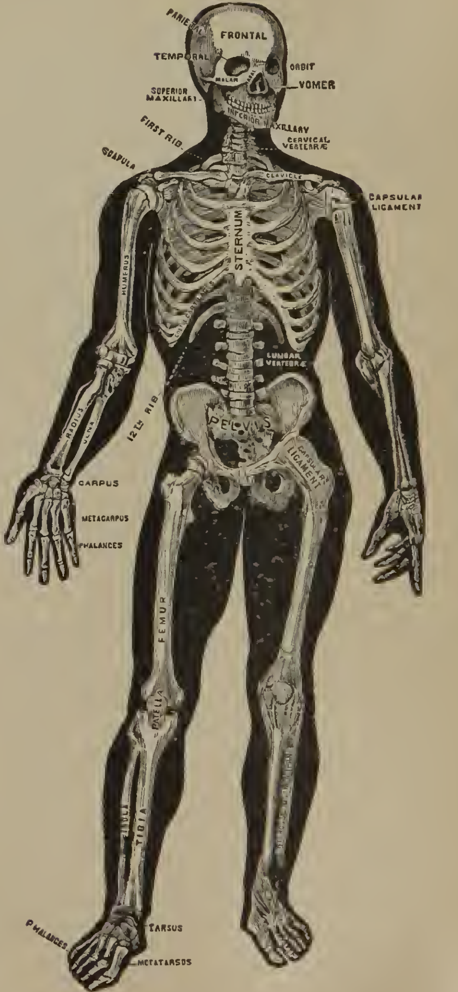

Fig. 5. — The Skeleton, and its Relation to the Contour of the Body.

The bones of the cranium are: one **frontal**, forming the forehead and the arches over the eyes; two **parietal**, covering the top and sides of the head, and separated from one another at the apex of the cranial vault; two **temporal**, occupying the temples on either side, and containing the organs of hearing; one **occipital**, occupying the lower back part of the cranium, which is called the occiput, articulating with the spinal column, and containing the large aperture, or *foramen magnum*, through which the spinal cord passes to join the brain; one **ethmoid**, occupying the lower anterior part of the cranium, and forming a part of the posterior chambers of the nose; and one **sphenoid**, lying at the bottom of the cranium, wedged in between the other cranial bones; it derives its name from the Greek word meaning wedge, and forms the keystone to the cranial dome.

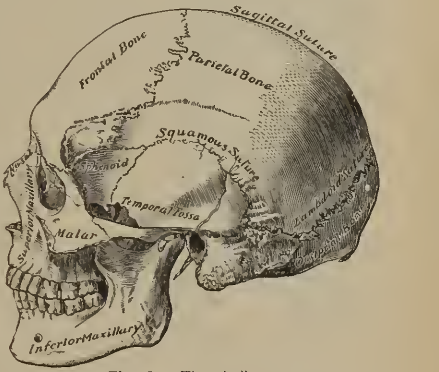

Fig. 6.—The skull.

The joints between the cranial bones are unlike those of the limbs, and almost entirely preclude movements of the bones in the child, and render them impossible in the adult. They consist of rows of tooth-like processes, which fit into corresponding depressions in the margins of the articulating bones, and are called **sutures**. There are eighteen of these, that between the two parietals being called the sagittal or arrow suture; that between the frontal and parietals being called the coronal or crown suture, that between the occipital and parietals being called lambdoid, from its resemblance to the Greek letter lambda, **Λ**; while the others derive their names from the bones which they join.

In infants, at the corners of the parietal bones, there are points not yet filled by bone, but covered by membrane. These are the "soft spots," and are called **fontanelles**. There are six of them. The largest, the anterior fontanelle, lies just above the forehead, at the junction of the sagittal with the parietal suture, and remains open until not later than the second year; the posterior fontanelle lies at the back of the head, at the junction of the sagittal and lambdoid sutures, and remains not filled by bone for several months after birth. The other four lie one before and one behind each ear.

The bones of the cranium present an external and internal table or layer of compact substance, with a layer of cancellous substance between them, called the **diploë**. Channelled in various directions throughout the diploë are many large and capacious veins, called the veins of the diploë. The internal table of the skull is remarkable for its brittleness, and for this reason is called the glass-like or vitreous table. Violence, insufficient to affect the tougher outer table, may break the inner table, so that a fracture of the inner face of a cranial bone may not be visible externally, even at the point where the violence was received.

Hollowed out in each temporal bone is the cavity containing the organs of hearing, — an exceedingly complicated structure, with three chambers, three intrinsic bones, and many other important parts, to which reference will be made in the chapter on The Senses.

The **face** owes its shape in a considerable degree to the bones, which aid in giving it beauty or ugliness. They determine the contour of the chin, the shape of the cheek, the height of the forehead, the size of the eyes, and the character of the nose.

They also contribute to the formation of a number of cavities, containing organs of the most vital importance to organized life. The orbits contain, on either side, the organs of sight; the nasal cavities are the site of the sense of smell; the mouth or buccal cavity is the location of the sense of taste, and the first of the cavities in which the process of digesting food occurs.

The bones of the face are: two **superior maxillary**, the upper jaw bones; two **malar**, the cheek bones; two **nasal**, forming the foundation of the nose; two **lachrymal**, thin plates filling an opening in the orbit; two **palate** bones, attached to the rear of the superior maxillary, and continuing the bony roof of the mouth; two **inferior turbinated** bones, forming the roof to the lower chamber of the nose; one **vomer**, shaped like a ploughshare, and separating the lateral halves of the nose; and one **inferior maxillary** bone, the lower jaw bone.

The upper and lower jaws contain the **teeth**, the function of which is the reduction of food to fragments in order to permit the penetration of the digestive fluids. Every tooth presents a **crown**, or body projecting above the gum; a **neck**, the constricted portion between the crown and the root; and the **root**, or fang set into the jaw bone. Each tooth also contains a pulp cavity filled with tooth pulp.

The teeth are composed of four distinct structures. (1) The **enamel** forms the outer covering of the crown, and consists of six-sided parallel rods, about $\frac{1}{5500}$ of an inch in diameter. It is the densest of all animal tissues and contains 96.5 per cent of mineral matter, which renders possible the use of the teeth in dividing even very hard foods. (2) The **dentine**, composing the greater part of the tooth, consists of wavy branching tubes called dental tubuli, about $\frac{1}{4500}$ of an inch in diameter and embedded in a hard substance called the inter-tubular tissue. (3) In the pulp cavity lies the **pulp**, a soft cellular substance, very freely supplied with blood-vessels and nerves, which enter at the tip of the root. (4) The **cement**, or crusta petrosa, consists of true bone and forms the covering of the root of the tooth.

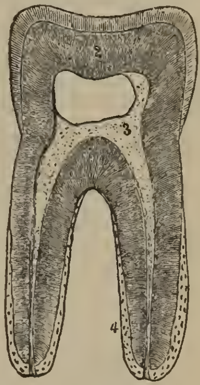

Fig. 7. — Structure of a tooth.

The teeth appear in two crops: (1) the **deciduous** or **milk teeth**, ten in each jaw, and (2) the **permanent teeth**, sixteen in each jaw. The four front teeth are provided with a wedge-shaped crown and are adapted for cutting food, whence they are called incisors: they have but a single root. On either side of the incisors are the canines, so called from their resemblance to those of the dog. They are spear-shaped, and adapted for rending food, — an evidence of the carnivorous phase of man: they also have but one root. Those in the upper jaw are vulgarly known as "eye teeth"; those in the lower jaw, as "stomach teeth." On either sides of these are two **bicuspids** or premolars, generally with a single root, and on either side of them are two **molars** or "grinders," with two or three roots. These teeth have a more or less cubical crown, the masticating surface of which is ridged to admit of the trituration or grinding of the food. The last molars are known as the "wisdom teeth." The molars represent the herbivorous phase of man.


Fig. 8. — The teeth.

At birth, the teeth have not yet appeared, and it is not until from the fourth to the seventh month that the lower central incisors push their

way through the gums, and are followed during the first two and a half years of life, in the order given, by the other incisors, the first molars, the canines, and the second molars. The eruption of the teeth through the gums — "teething" — is commonly attended by more or less disturbance of the system, varying from a slight indigestion to violent convulsions. Where the trouble is sufficient to demand interference, a slight cut in the gum over the coming tooth will relieve it.

During the years following their appearance, in sacs at the roots of the deciduous teeth, a second set of teeth has been forming, which, as they grow, press upon the deciduous roots until they cause their entire absorption, leaving only the crowns, which are finally cast off, leaving room for the new permanent teeth. The first permanent teeth to appear are the first molars at the end of the sixth year, followed during the next six or seven years, in the order given, by the incisors, the bicuspids, the canines, and the second molars, while the appearance of the third molars or wisdom teeth is delayed until the age of seventeen to twenty-one years.


Fig. 9. — The spinal column.

The spinal column or "backbone" consists not of a single bone, but of a chain of small bones called vertebræ so locked together that the degree of motion between any two is limited, although that of the entire column is considerable. This gives it flexibility and permits the bending of the body. The cartilages between the vertebræ give it elasticity and prevent frequent stunning. At the same time it possesses great strength and firmness. It encloses and protects the spinal cord, forms a basis for the attachment of the muscles of the trunk and for those which maintain the body in the erect posture. Its bones are not arranged in a straight line, but in four gentle curves, which not only add greatly to the beauty of the contour, but very greatly increase its strength; they also add to the elasticity of the spine and assist in the formation of the cavities for the lodgement of internal organs.

There are seven cervical vertebræ, which enter into the

neck; twelve dorsal vertebræ, which enter into the chest, and from which spring the twelve ribs; five lumbar vertebræ, forming the framework of the loins; five sacral vertebræ, which are fused into a single bone, the **sacrum** or "rump bone," which forms the keystone of the pelvis; and four coccygeal vertebræ, also consolidated into a single bone, the **coccyx,** which forms the human rudimentary tail, and receives its name from its fancied resemblance to the beak of the cuckoo: the spinal column then, formed by thirty-three vertebræ, consists in reality of but twenty-six distinct bones. The cervical, dorsal, and lumbar vertebræ are called true vertebræ, and the sacral and coccygeal are called false vertebræ.

Each vertebra consists of a main portion like a segment of a solid cylinder and called the body. From the back of this body spring two plates which meet and form an arch, the vertebral arch, circumscribing an aperture which is a segment of the spinal canal. It presents a number of projections called processes, the chief of which springs from the posterior surface of the vertebral arch and is called the spinous process. The lowest cervical vertebra — the seventh — has a noticeably long spinous process, and for that reason is called the vertebra prominens. It can easily be felt at the base of the neck. Indeed, with the exception of those of the few upper vertebræ of the neck, the spinous processes of all the vertebræ can readily be felt, particularly if the body be bent forward and the arms drawn across the chest. Having identified the vertebra prominens by feeling, the others can readily be recognized by counting from it. It may be well to remark also that the seventh dorsal vertebra lies on a level with the lower angle of the shoulder blades, while the fourth lumbar vertebra is on a level with the highest point of the hip bones.

Having become acquainted with the relations of the vertebræ to the principal organs of the chest and belly, the knowledge of how to identify the vertebræ renders it easy to discover what organs may probably have been injured in case of a wound of the body. In connection with the viscera (p. 143) will be found a table in which these relations are very clearly stated.

The hunchback owes his hump to the fact that the bodies of certain of his vertebræ have been worn away, rendering the curve of the back more pronounced, so as to make a prominence of greater or less size.

Between the vertebræ are certain elastic discs called the intervertebral cartilages, which act not only as buffers between the bones, but also as ligaments to hold them together. These discs yield to weight and flatten out to a slight extent; even the weight of the head and body will

have some effect upon them, so that every person is shorter when he retires at night than when he arises in the morning. They also yield in any direction to adapt themselves to any desired attitude; this yielding may become permanent and result in deformity, if a vicious attitude be habitually maintained, as in the one-sided attitude sometimes assumed by the clerk who leans all day over his desk, or the stoop seen in the farmer who constantly bows over hoe or plough in his work.

The first two cervical vertebræ, called respectively the atlas and the axis, are peculiar in that the atlas has no body, but is simply a ring of bone moving about an upward extension of the body of the axis. It is supposed that at first these vertebræ were like the others, but that in the evolution of the skeleton, in order to permit greater mobility of the head, the body of the first became fused with that of the second, forming the upward projection known as the odontoid process of the axis, and the first became the bony ring now known as the atlas, from its supporting the head as the mythical Atlas was wont to balance the earth on his shoulders.

The atlas is joined directly to the skull, and the spinal canal at this point becomes continuous with the foramen magnum of the occipital bone.

In front of the vertebræ is a small horseshoe-shaped bone not attached to any other, called the **hyoid bone.** It lies just above the larynx, which may readily be felt in the neck, the front of it being known as the "Adam's apple." This bone is a very important part of the foundation of the tongue, and also gives attachment to the muscles which give the contour to the chin.

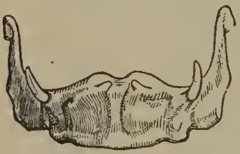

Fig. 10. — The hyoid bone.

The **thorax** is a bony cage designed to contain and protect the heart and lungs. The foundation of the thorax is the dorsal portion of the spinal column. Passing out from each one of the dorsal vertebræ are the **ribs**, twelve on each side, ten of which turn again to become united with the **sternum** or "breast bone" in front by means of the **costal cartilages,** thus taking the shape of a sickle. The twenty-four ribs are known by their numbers on either side from top to bottom, the upper rib on either side being the first rib, right or left, etc. The eleventh and twelfth ribs, which are not attached to the sternum, are called "floating ribs."

The **sternum** or "breast bone" is a flat bone from six to seven inches long, which was compared by the ancients to a sword, and considered in three pieces; the upper they called the *manubrium* or handle, the middle and longest part is called the *mucro* or blade, while the third and smallest portion is called the *ensiform appendix* or sword-like appendage.

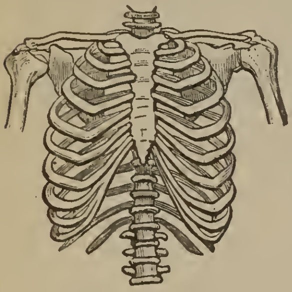
Fig. 11. — The thorax.

The **costal cartilages**, to which reference will again be made under the head of Cartilage, are tough, elastic continuations of the ribs, connecting them with the sternum and by their elasticity permitting movements of the chest in breathing, which would be impossible were the ribs and sternum joined directly together. This peculiarity will be fully considered in connection with the subject of breathing.

The upper extremity consists of the shoulder, the arm, the forearm, and the hand, and is formed by the scapula, the clavicle, the humerus, the radius and ulna, the carpus, and the bones of the hand. The length of the upper extremities should be exactly proportional to the height of the person. When the arms are outstretched in the same horizontal line, the distance between the tips of the middle fingers should be equal to the height.

The shoulder is formed by the scapula, the clavicle, and the upper end of the humerus.


Fig. 12. — The shoulder blade.

The **scapula** or "shoulder blade" is a broad, triangular, flat bone, which lies upon the upper back part of the thorax, covering the first

seven ribs. Its anterior surface is smooth and slightly concave, while from its posterior surface springs a sloping ridge known as the spine, the outer apex of which — the acromion — projects over the shoulder joint to protect it and prevent the arm bone from slipping up. At the outer angle is found a shallow cup facing outward, — the glenoid cavity, — which receives the rounded head of the arm bone. The scapula also contributes largely to the strength of the thorax and affords an extensive surface for the attachment of many of the powerful muscles of the upper extremity.

Fig. 13. — The collar bone.

The **clavicle,** or "collar bone," so called from its resemblance to an ancient key, "clavis," is a long bone about six inches in length, shaped like an italic letter *s*, and readily felt under the skin. Extending in a horizontal line from the sternum to the scapula, it acts as a prop to the shoulder, bracing it upward, outward, and backward. This function is very clearly seen in broken collar bone, when the shoulder falls downward, inward, and forward. Another important function is the protection of the great vessels of the upper extremity as they pass out of the thorax into the arm, under the arch formed by the outer curve of the clavicle. Pressure between the first rib and the collar bone will discover the beating of the artery, and, in case of an injury to the arm, bleeding may be checked by pressing this vessel against the first rib behind the clavicle.

The **humerus** or "arm bone" is a long bone with a head, a shaft, and a broadly flattened lower extremity, extending from the shoulder to the elbow. The rounded head fits into the socket formed by the glenoid cavity of the shoulder blade. The shaft is cylindrical and light; its junction with the head is called the surgical neck, on account of the frequency with which the bone is broken at this point. The lower end of the bone spreads out flatly to form a part of the hinge of the elbow. A projection on either side of the bone can readily be felt in every elbow; these projections are the condyles, about which the strong muscles of the forearm are attached. On the anterior and posterior face, between the condyles, are depressions for receiving the projections of the ulna, the bone at the bottom of these cavities being extremely thin. It should be observed that the shoulder

Fig. 14. — The humerus or arm bone.

joint is a ball and socket joint and almost universal in its movements, permitting the upper extremity to act in every direction.

The portion of the upper extremity between the elbow and the wrist is called the **forearm**, and is formed by two parallel long bones, the **ulna** and the **radius**. The ulna is the larger bone of the forearm, and lies on the same side as the little finger. It receives its name from the Greek word meaning elbow, because of its participation in that joint. It does not enter into the wrist joint at all. The most peculiar feature of the ulna is the hook-like olécranon process at its head, in front of which the bone is hollowed out into the greater sigmoid cavity to receive the cylindrical lower end of the humerus into a hinge joint. This process is of the greatest importance; it gives leverage to the great muscle which enables the pugilist to "strike out"; it prevents the elbow from bending backward, and it protects the joint in leaning or striking on the elbow. From the front of the upper end of the ulna projects another but less important process, the coronoid process. The ulna terminates below in a blunt projection, the styloid process, the prominence of which can readily be felt and frequently seen in the living wrist.

Fig. 15. — The ulna and radius or forearm bones.

The **radius** receives its name from its resemblance to the spoke of a wheel. It is a long bone, on the same side of the wrist as the thumb, lighter than the ulna, and, unlike that bone, is broader at the lower end than at the upper. It enters but very slightly into the elbow joint, and alone of the forearm bones enters into the wrist. Both its ends rotate upon the ulna, — a provision which enables the hand to be turned palm upward or downward at will. The rolling of the radius upon the ulna, to turn the palm downward, is called **pronation**; the reverse motion, turning the palm upward, is called **supination**. The lower end of the radius is broadened and hollowed out to receive the wrist bones; and on its inner face is a projection, called the styloid process of the radius, which can readily be felt in the living. The lower end of the radius is very frequently broken by persons falling upon the palms of the hands, or very violent pushing with the palms.

It should be observed that the bones of the forearm do not lie in the same line as the arm bone, but that they form an obtuse angle with it. This provision makes it possible for the hand to be carried at some distance from the side, when the arm is held tightly against the ribs,

and gives to the upper extremity the "carrying function," enabling a person to carry a weight in his hand with the elbow braced against the side.

The wrist is formed by the **carpus**, consisting of eight small bones, arranged in two horizontal rows, called respectively, counting from the thumb inward, scaphoid, semilunar, cuneiform, and pisiform, in the upper row, and trapezium, trapezoid, os magnum, and unciform in the lower row. The contiguous surfaces are encrusted with cartilage, and form regular joints. The division of the wrist into so many bones gives it strength and elasticity, together with a certain degree of motion, and it renders the liability of the wrist to be dislocated or broken vastly less than if it consisted of a single bone.

Fig. 16. — The bones of the hand and wrist.

The **hand** is composed of nineteen long bones, arranged end to end in five lines, corresponding to the five digits, the thumb presenting three bones, and each of the fingers four. The bones adjacent to the wrist are called metacarpal bones, and the group of five metacarpal bones is called the metacarpus. The remaining bones are called phalanges, and numbered in each digit from the metacarpus to the tip, — first, second, and last or ungual phalanges. The spaces between the four metacarpal bones belonging to the fingers is filled, in the living person, with muscles and other organs, and the entire mass covered with skin, the front of it being the palm of the hand. The thumb is entirely independent from the beginning, and is peculiar not only in possessing but two phalanges, but also in having its action opposed to that of the fingers, which greatly facilitates the grasping of an object. For this reason the loss of the thumb disables the hand more than that of any of the fingers; indeed, the loss of all of the three outer fingers would not affect the usefulness of the hand as much as that of the thumb alone.

The hand is a piece of mechanism most wonderfully adapted to the thousands of purposes for which it is designed. Even the unevenness in the length of the fingers adds to its utility as well as its beauty. As an implement of labor, its uses are almost innumerable; but it is also a most important feature of expression. In the words of Quintilian, it may express desire or willingness, it may bid one come or go, it may threaten or supplicate, it may display defiance or fear; joy or sadness, doubt or penitence, want or plenty, number or time, may all be shown by it.

The **pelvis** is a great bony arch supporting the body and transmitting its weight to the lower limbs; it is a basin con-

taining and protecting a number of important viscera, whence the French call it "*le bassin*." It is composed of four bones, the innominate or "hip bones," on either side, and the sacrum or "rump bone," in the centre at the top, forming, as has already been observed in connection with the spine, the keystone of the pelvic arch. Attached to the lower end of the sacrum is the coccyx, which does not enter into the arch, but assists in the formation of the pelvic cavity.


Fig. 17.—The pelvis or hip bones.

About the circumference of the pelvic cavity runs a line where the bone is thickened, and forms a projecting ridge; this ridge is the brim of the pelvis. All that portion above the brim is called the false pelvis, and the portion below is called the true pelvis. The pelvis differs slightly in the two sexes. In order to facilitate childbirth in the female, the sacrum is wider and less curved, the cavity shallower and broader, and the pubic arch has a broader span.

The pelvic arch is enormously powerful; a wagon containing over five tons has been known to pass over it without breaking the bones. The sacrum, shaped like the keystone of an arch and performing that function here, directly supports the spine while the hip bones act as the pillars of the arch in continuation with the bones of the lower limbs. The bones of the pelvis afford extensive surfaces for the attachment of the immensely powerful muscles of the trunk and lower limbs.

The upper margin of the **innominate** or *hip bones* may readily be felt in the living person. In the direct line of the weight of the body on the outer convex surface of each hip bone, is a projecting cup with a hemispherical cavity called the acetabulum or vinegar cup. This is the socket into which the ball-like head of the thigh bone is set to form

the hip joint. The hip bones are formed by the fusion of three bones which are more or less distinct up to adult age, and which meet at the bottom of the acetabulum. The upper flaring portion, which may be felt at the hip, is the ilium; this portion enters more extensively into the pelvic arch when standing. The thick heavy portion on the under and back part is called the ischium, and enters into the arch more particularly in the sitting posture, these bones forming the supports of the body in that attitude. The lighter portion, with a large aperture, the obturator foramen, in its centre, and uniting with its fellow of the opposite side in front of the body, is called the pubes; these portions of the innominate not only form the front of the pelvic cavity, but act as a tie-beam for the pelvic arch.

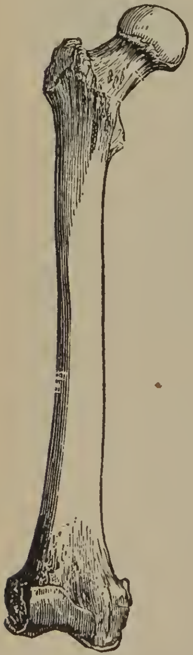

Fig. 18. — The femur or thigh bone.

The lower extremity includes the **hip,** already referred to; the **thigh,** extending from the hip joint to the knee; the **leg,** extending from the knee to the ankle; and the **foot,** from the ankle to the tips of the toes.

The **femur** or thigh bone is the longest and strongest in the body. Its length is a peculiarity of the human skeleton. The finger tips in man reach about to the middle of the thigh; in the most man-like of the monkeys they reach to the knee, and in others to the ankle, because of the shortness of the thigh bones. These bones do not stand perpendicularly.

Like other long bones, the thigh bone presents two extremities and a shaft. The head is practically a ball mounted upon a somewhat smaller neck; this head is very firmly fixed in its socket, the acetabulum of the hip bone, and the motion of the joint is very free, so that the lower limbs swing like pendulums in walking, and the muscles need have but little to do either with keeping the bone in place or in moving the limb in walking. The head is mounted upon a portion of the shaft which is set somewhat at an angle with the rest, and is called the neck; in infancy, this angle is quite obtuse, but it diminishes with age until in the old it may be even less than a right angle. This, in addition to the fact that its compact tissue becomes less and its cancellous tissue

greater in amount, renders the neck of the femur much more liable to break in old persons than in the young.

At the other end of the neck are two projections called the greater and lesser trochanters, to which the great hip muscles are attached. The great trochanter can readily be felt a few inches below the prominence of the hip. The shaft is very strong, and ridged and roughened in places for muscular attachments. The femur, like the humerus, widens as it approaches its lower extremity and presents a prominence on either side called the internal and external condyles. The two condyles are separated by an intercondyloid notch, dividing the end of the bone into two hemispherical portions which participate in the knee joint.

In the tendon of the great muscular mass which straightens the knee, and directly in front of the knee joint, is found a triangular bone, the **patella** or "knee cap." It not only protects the joint, but increases the leverage of the muscles so as to add greatly to their power. It fits down into the intercondyloid notch when the knee is bent, but it lies quite free when the leg is straightened. When this bone is broken, the power of straightening the leg is lost.

Fig. 19. — The patella or knee cap.

The leg has two parallel long bones. The **tibia** or "shin" bone is vastly the larger, and alone articulates with the thigh bone, and almost alone with the foot. Next to the femur it is the largest and strongest bone in the skeleton, and the two tibiæ sustain the entire weight of the body. Both its upper and lower ends are widened, the upper more than the lower, while the shaft has the form of a prism. The top consists of two shallow cups separated by a slight elevation called the spine; in these cups lie and move the condyles of the thigh bone. Just below this, in front, is a projection to which is attached the great muscle which straightens the leg. Its lower end is somewhat hollowed out to receive the upper extremity of the foot. Extending downward and inward is a process which prevents the foot from being dislocated inward; this makes a projection under the skin which is called the **internal malleolus.** The shin bone lies directly under the skin, in front, where its angle can readily be felt.

Running parallel with the shin bone is the **fibula,** so called from a Latin word meaning clasp. In proportion to its length, it is the most slender of all the long bones. It does not sustain any of the weight of the body, nor does it enter into the knee joint. It is attached to the tibia just below and external to the knee, and passes down the leg to project as a process just below and external to the ankle. Firmly attached to the tibia at this point, it prevents the foot from being dislocated outward and forms the **external malleolus,** readily seen and felt

under the skin. This bone is frequently broken about two and a half inches above the ankle by a sudden twist of the foot, the shin bone remaining unaffected. This injury is called "Pott's fracture."

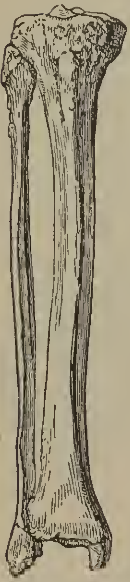

Fig. 20. — The tibia and fibula or leg bones.

There are twenty-six bones in the **foot,** divided among the tarsus, the metatarsus, and the phalanges. The multiplication of bones produces an increased freedom of motion and greater elasticity, like the similar condition in the wrist.

The **tarsus,** producing what the shoemakers call the "instep," is analogous to the carpus in the wrist. It is composed of seven **tarsal bones,** — the astragalus, which enters into the ankle joint, the calcaneum, the scaphoid, three cuneiform, and the cuboid bones.

There are five **metatarsal bones,** numbered first, second, etc., from within outward; unlike the metacarpus, all five of the metatarsal bones are included within the same covering of skin, the interspaces being filled with muscles and other soft parts. Beyond the metatarsus are found the phalanges of the foot, three in each toe, except in the great toe, which, like its analogue the thumb, has but two, and, like those of the fingers, they are called first, second, and ungual phalanges. The ungual phalanx of the little toe is very often fused with the second. In antique art the second toe is represented as longer than the first, but in the present age the great toe is found to be the larger in a great majority of cases.

Fig. 21. — The bones of the foot.

The foot forms two very important bony arches, one longitudinal, with the calcaneum behind and the heads of the metatarsus in front as its pillars, and the astragalus as its keystone; the other arch is transverse, with its greatest convexity at the instep and its inner side thicker than the outer, while the cuboid and the cuneiform bones are so shaped as to unite in keying the arch. The absence of these arches constitutes flat foot.

In the bony framework of the body the arch, as a means of economizing material, is freely used. The skull is a dome of which the sphenoid bone is the keystone. The upper extremities and the chest form an arch, of less importance than some others, and yet not to be neglected. The ribs, the sternum, and the spine form a series of arches. The pelvic arch has been described in detail, the lower extremities forming its columns. And those of the foot have just been noted.

CHAPTER IV

THE HINGES — THE JOINTS

A **joint** is the juncture of two adjacent bones. Anatomists enumerate nineteen different kinds of joints in the human body. They may be (1) immovable, like the sutures between the bones of the skull-cap; (2) permitting but limited motion, like those between the vertebræ; and (3) freely movable, as in the shoulder and other commonly recognized joints.

Of the movable joints, three are worthy of note: (1) The **ball-and-socket joint,** enabling the limb to be freely moved in all directions: this is the case with the shoulder joint, where the ball-like upper end of the arm bone fits into the glenoid cavity of the shoulder-blade; the spherical head of the thigh bone is set in a similar way into the acetabulum of the hip bone. (2) The **hinge joint,** where the movement is limited practically to two directions, like a hinge: the knee and elbow joints are the most conspicuous examples of this. (3) The **rotatory joint,** where the end of one bone turns in a ring formed partly by the other bone and partly by a fibrous loop: this is seen in the joint between the upper ends of the two arm bones, the upper end of the radius revolving in a ring formed by a fibrous loop and a depression in the upper end of the ulna.

The bones in a movable joint are retained in juxtaposition only to a small extent by the bony structure, and to a much greater degree by ligaments and muscles. The character of

the ligaments, together with the shape of the adjoining portions of bone, determines the character of the joints. The parts of the bones participating in the joint are coated with a bluish white elastic substance known scientifically as cartilage and popularly as "gristle"; sometimes, also, cartilage, strengthened by fibrous matter, is found at the edge of joint cavities, contributing to deepen them; in some cases ligaments lie within the joint cavity, and, covering all, is a capsule of fibrous tissue: the capsule also has a serous lining called the synovial membrane.

Ligaments are masses of white fibrous tissue designed to unite separate bones. They may consist of bundles or cords extending from one bone to another, or they may take the form of capsules surrounding and covering the entire joint. The number of ligaments may vary from one, as seen in the joint between the upper ends of the bones of the forearm, to fifteen, as seen in the knee. While pliable and flexible so as to permit great freedom of motion, ligaments are strong, tough, and, with few exceptions, inelastic. They are attached to the bones by a mutual interlacement with the fibres of the periosteum.

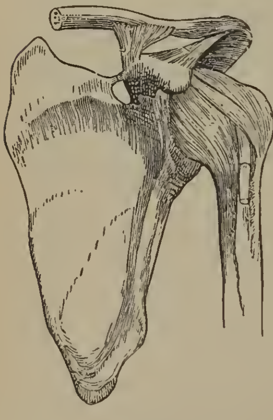

Fig. 22. — The shoulder joint, a ball-and-socket joint. Showing also ligaments connecting the collar bone with the shoulder blade.

They are sometimes so powerful that the bone will be torn off before they are broken. A rupture of the ligament in front of the wrist joint is almost unknown, while the tearing off of the end of one of the bones of the forearm, the radius, by force exerted on the ligament, is one of the most common forms of broken bones. A similar condition is observable at the knee joint, where the "knee cap" is broken very much more frequently than the portions of the ligament attached to either end of it. In other joints the ligaments are com-

paratively weak, in consequence of which some bones are much more frequently put out of joint than others. At the shoulder joint, where there is practically but one not very strong ligament, dislocations are very frequent, while at the knee, with its fifteen ligaments, that accident is almost unknown.

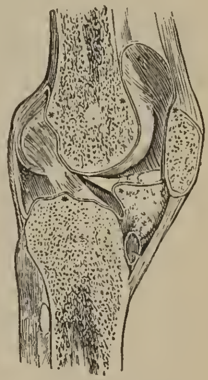

Fig. 23. — The knee joint, a hinge joint, cut down the middle to show the relations of the bones and the ligaments.

A few ligaments consist of yellow elastic tissue. Such are the ligamenta subflava running down the side of the spine. Such also is the ligamentum nuchæ, extending from the vertebræ of the neck to the back of the head. The elasticity of this ligament is very important in the lower animals, whose neck habitually assumes a horizontal attitude; for when the head is lowered, as in grazing, it may be elevated to its natural position by simply relaxing the muscles, and it is maintained in that position without weariness simply by the elasticity of this ligament.

Fig. 24. — The joint between the upper end of the forearm bones, a rotatory joint. The radius has been removed to show the fibrous loop.

About the wrists and ankles the white fibrous tissue called the fascia, which lies underneath the skin throughout the body, is thickened to such an extent as to form a strong ligament-like ring. These rings are called the annular ligaments of the wrists or ankles, and their function is to hold the tendons of the muscles moving the hands and feet close to the bone, thus giving additional power to their action.

The **synovial membrane** is a delicate membrane lining the capsules of joints and covering all ligaments that may be contained within joints, but not covering the cartilage. It secretes the synovia, or "joint oil," a yellowish or slightly reddish fluid, something like the white of an egg in feeling, which has for its function the lubrication of the joint.

In some joints the synovial membrane is thrown into folds which cross the joint and are known as **synovial ligaments.** Synovial membrane is also found lining certain **bursæ** or pockets interposed between certain muscles and the bony surfaces over which they play, and certain sheaths, **synovial sheaths,** through which play the tendons of still other muscles; in both these cases the secretion fulfils its function of lubrication. The synovial membrane is subject to inflammation in all these localities, producing an affection called "synovitis."

Cartilage is a tough bluish or yellowish white elastic substance, which, when found in meat on the table, is called "gristle." It is the precursor of bone; even up to adult age some bones remain partly cartilaginous, while in the embryo the skeleton is almost altogether cartilage, the bones of the skull cap being the only exception. A child, then, has far more cartilage in his system than a man. In the adults it forms caps for the ends of the bones, and, by its elasticity, contributes to the diminution of shock and friction between them. It forms a large part of the walls of the windpipe and bronchial tubes, where it serves to maintain rigidity and prevent collapse; it performs a similar function in the nose and ear, combining firmness and yielding. It supplies an elastic material in the costal cartilages, which form a part of the cage containing the breathing apparatus.

There are no blood-vessels in cartilage, which reduces its liability to inflammation, to which its situation and its subjection to pressure would incline it otherwise. It imbibes its nourishment from adjacent tissues.

The compressibility of cartilage, with which the ends of all bones are encrusted, makes possible another curious circumstance. Every person is taller upon arising in the morning than when retiring at night! This is due to the weight of the body in an erect posture acting upon the intervertebral and other cartilages so as to flatten them, their elasticity causing them to regain their original thickness at night, when, in the recumbent posture, all weight is removed.

The value of this elastic substance between the bones, where it acts as a buffer, cannot be overestimated. Walking or jumping would be almost impossible were it not for this means of diminishing the jar which would be felt if the bones were directly in contact.

Combined in the way described, the bones of the skeleton are joined together, every joint having a distinctive name.

The shoulder, elbow, and wrist, the hip, knee, and ankle joints are familiar to every one. The knuckles, or metacarpo-phalangeal and the first and second interphalangeal joints in the fingers, are better known than the corresponding metatarso-phalangeal and interphalangeal joints of the foot and toes. The intercarpal and carpo-metacarpal joints of the wrist, and the intertarsal and tarso-metatarsal joints in the foot, are still less known. Joints between vertebræ and ribs, between the spine and the head, and between the head and the lower jaw, are all present and are considered by the anatomist.

CHAPTER V

THE MOVING APPARATUS—THE MUSCLES

Having become acquainted with the bones and the joints which permit them to move in relation to one another, the question of the means of producing the movements naturally arises. The motive power of the body lies in the muscles.

Muscles are "lean meat." Upon examination of the steak or roast, fibrous lines will be seen intersecting the meat in various directions, and, extending the examination to the beef before it is cut, these intersections will be seen to form sacks of considerable extent surrounding masses of meat of varying form and size, but alike in being attached at two extremities to bones. These masses are the individual muscles, and the fibrous intersections are sections of the weblike fibrous tissue, called fascia, which encloses not only each muscle, but certain masses of muscle and the entire body.

The action of muscles is produced by the contraction and relaxation of their fibres shortening and lengthening the muscles, and thus bringing nearer together the two bones to which its ends are attached. This is well seen in the biceps muscle of the arm, one end of which is attached to the

shoulder and the other to one of the forearm bones. When the biceps is contracted, it draws the forearm and hand toward the shoulder, and when it relaxes, it allows the arm to be thrown out straight. When a muscle contracts, it also grows thicker, as each person may see for himself by strongly drawing his forearm up toward the shoulder and feeling the thickness of the biceps muscle in front of his arm. The contractile character of muscle is also shown by the wide separation of the lips of a cut into a muscle, the fibres on either side contracting and drawing them apart.

The muscles act upon the bones, producing motion in various directions; these motions have received distinct names. When a limb is simply bent, as in bending the elbow or knee, the motion is called **flexion**, — the limb is flexed; straightening the limb is called **extension**, — the limb is extended: the movements, **pronation**, turning the palm downward, and **supination**, turning it upward, have been described. Turning a limb about its long axis is called **rotation**. **Abduction** is throwing a limb outward, as when a leg is thrown to one side. **Adduction**, drawing a limb inward, is the reverse of abduction.

Fig. 25. — Voluntary muscular fibres. *aa*. Large collections of fibrils. *bb*. Smaller collections of fibrils. *c*. Still smaller collections. *d*. The smallest that could be separated.

Muscles produce all voluntary and some involuntary motion. If a man in walking catches his foot against an obstruction and falls, the fall is involuntary motion; but when he throws his other foot forward to regain his equilibrium, that is involuntary motion. There are in the body both voluntary and involuntary muscles. The voluntary muscles are those which are under the control of the will, like those of the jaws, the arms, and the legs. The involuntary muscles are those over which the will has no control, such as the heart and the muscles of the bowels. The word *muscle*, unmodified, is used in this book to signify voluntary muscle.

Voluntary muscles are also called striated, and the involuntary nucleated, from their appearance under the microscope. The fibres of voluntary muscle consist of fasciculi about $\frac{1}{400}$ of an inch in diameter across which are seen regularly arranged transverse lines or striæ, each **fasciculus** being enclosed in its own fibrous sheath or perimyseum. The fasciculi are united into a single bundle by means of a network of fine white connective tissue. The fasciculi are composed of a number of smaller fibrils about $\frac{1}{18000}$ of an inch in diameter, also enclosed in a transparent elastic sheath, the sarcolemma: each of these fibrils is composed of a series of discs or "sarcous elements" arranged end to end like a roll of coins. The contraction and extension of these discs produces the contraction and extension of the whole muscle.

Involuntary muscles are composed of spindle-shaped cells, each with a clearly marked nucleus, but not striated. They are about $\frac{1}{500}$ of an inch long by $\frac{1}{4000}$ of an inch broad, and are found in the muscular coats of the stomach, bowels, bladder, arteries, veins, and the heart and lungs. Involuntary muscles are not, then, attached to bones, and their contractions are irregular, one part contracting while a contiguous portion is relaxing, — a movement which may readily be seen in the intestines, where it is called the peristaltic motion.

Fig. 26. — Involuntary muscular fibre, magnified 350 times. *a*. Nucleus of the fibre.

The advantage of the provision of involuntary muscles is evident; for if it required an effort of will to cause their action, one might forget to breathe or to keep his heart beating, and die. But the involuntary muscle continues to act irrespective of the individual — the heart beats on, sleeping or waking, the stomach and bowels proceed with the act of digestion, and the lungs contract and expand in breathing regardless of the will of their owner or any surrounding circumstances.

If the muscle which moves a limb be severed, the power of motion in the limb is lost. The voluntary are generally so arranged that the action of one group of muscles is counterbalanced by that of another. In the case, for instance, of a wound across the back of the hand dividing the muscles opening it, those closing it would have no opposition, and the hand would remain permanently closed; the reverse would be the case if the palm should receive such a wound.

It frequently occurs that these muscles of equilibrium are not attached to directly opposite portions of a bone; so that the bone may be broken between them and the broken ends of the bone drawn in opposite directions. This is shown in Fig. 27, where the thigh bone is broken between the psoas iliacus and the short head of the biceps cruris muscles, resulting in great displacement of the fragments. This action of muscles is of great importance in connection with broken bones, and will be referred to again in connection with that subject.

Fig. 27. — A fracture of the thigh bone, showing the action of the psoas iliacus muscle in pulling the upper fragment out of place. A portion of the biceps is seen pulling the lower fragment in the opposite direction — the two muscles counterbalancing one another when the bone is whole.

A similar effect is produced when a bone has been thrown out of joint: the end which has escaped from its socket being held out of place by the tension of muscles, which must be relaxed before it can be returned.

Muscles constitute the greater portion of the body, and to them it chiefly owes its contour. The calf of the leg, for instance, is composed entirely of muscles. The most beautiful figure, then, is the one in which the muscles are most uniformly and symmetrically developed, irregularities between them being filled in with fat. This function alone would require the existence of a large amount of muscular tissue, and, as a matter of fact, there are about four hundred and forty muscles in the human body, arranged in symmetrical pairs, one on each side of the body and forming about two-fifths of its weight.

Muscles vary greatly in shape, some being cylindrical or spindle-shaped, others broad and thin, while still others are long and ribbon-shaped. Those of the arm and thigh are required to be the thickest in the body because of the heavy work required of them. The muscles of the abdomen and cheek on the contrary are broad and thin because they are designed to form walls to cavities. Muscles increase in size in proportion to their use. This fact is shown by comparison

of the powerfully muscular athlete, who devotes himself to the exercise of his muscular system, with the thin, flabby man of sedentary occupation who neglects exercise. If a muscle be unused for a long time, it suffers not only diminution in size, "atrophy," but degeneration of its tissue, which is permanently fatal to its usefulness.

Muscles begin at their attachment to one bone with reddish muscular tissue and end in inelastic glistening white fibrous tissue, forming the cord-like or strap-like tendons which are attached to the other bone and are commonly known as "sinews," "leaders," or "cords." Where a muscle has a broad attachment, the tendon may be expanded into a strong fibrous sheet which is called an aponeurosis. Muscles may begin in several masses terminating in a single tendon as in the triceps, "three-headed," or biceps, "two-headed," muscles of the arms. Or they may begin as a single muscular mass and divide into a number of distinct tendons as in the forearm muscles which open and close the hand. Tendons are attached to bone by a mutual interlacement of their fibres with those of the periosteum.

Within from seven to twenty-four hours after death, by reason of certain chemical changes, all muscles become rigid, producing what is known as **rigor mortis**, the stiffness of death, and the muscular tissue loses its contractility. The contractile power is a quality requiring the stimulus of vitality for its exercise, and although beginning decomposition relaxes the muscles again, it does not return. In persons suffering from great muscular exhaustion immediately prior to death, as in soldiers killed in a battle, rigor mortis sets in very quickly. In this way the attitudes and expressions of life are sometimes continued after death upon the battle-field.

An important group of muscles is the muscles of expression in the face. As a rule, but one end of these muscles is attached to bone, the other being inserted into the skin. Joy and grief, pleasure and disappointment, anger and satisfaction, are made evident in the countenance by the contraction and relaxation of these muscles. The occipito-frontalis is the muscle of the scalp, and produces the horizontal wrinkles in the forehead. The orbicularis palpebrarum and the orbicularis oris each aid in closing the eyes and mouth respectively, while the square masseter,

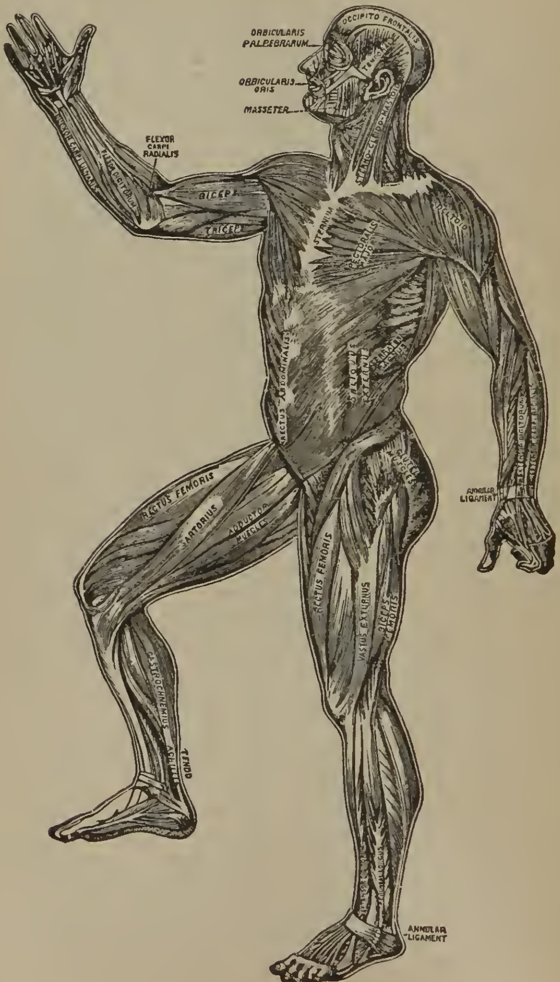

Fig. 28.—The Chief Superficial Muscles of the Human Body.

aided by the temporal, contributes largely to the powerful closure of the jaws.

Beginning just back of each ear and passing down the neck to the front of the breast bone are two muscles, one on each side, the sterno-cleido-mastoid muscles. They can readily be felt under the skin of the neck, and are for this reason of importance in marking the course of the great arteries of the neck, which run just in front of them. When one of them, through disease, becomes permanently contracted, the common affection "wry neck" is produced by the consequent drawing of the head to one side.

On the chest lies the great fan-like chest muscle, the pectoralis major, extending from the chest to the arm bone and tending to draw the arm inward and forward. Just above this is the deltoid, a great triangular muscle attached to the shoulder and the arm bone and raising the arm to a right angle with the body. On the back the serratus magnus and a number of scapular muscles extend from the shoulder blade to the arm bone and draw the arm backward and inward. Another great muscle extends from the spine over to the arm bone and draws the arm downward and inward, or, if one hangs by the hands, it lifts the body upwards — this is the latissimus dorsi.

In the arm, the biceps muscle extends down the front and bends the elbow, while the triceps extends down the back and straightens the arm. The biceps can be felt under the skin, and its inner border is a landmark for the great artery of the arm. In the forearm are the muscles which move the wrist, hand, and fingers. In front and on the external side of the forearm are the extensor muscles which straighten the wrist, hand, and fingers. These tendons, beginning above the wrist, extend down the back of the hand, like cords, which can readily be felt under the skin. On the back and inner side of the forearm are the muscles which bend the hand, wrist, and fingers; the flexor muscles, the tendons extending from the forearm to the hand. In the forearm are also pronator muscles which turn the palm downward, and supernators which turn it up.

In the lower extremity are the glutei muscles, extending from the hip to thigh bone and drawing the thigh outward. Passing from the pubic bone to the thigh is a mass of adductor muscles which counterbalance the action of the glutei. In front is the great four-headed muscle, composed of the rectus femoris, the vastus externus and internus, and the crureus, uniting into a single tendon in which the knee-cap is set, and acting together to straighten the knee. On the back are the biceps femoris and other hamstring muscles, which bend the knee, and whose tendons can readily be felt standing out under the skin, just above the back of the knee. The thigh muscles are the largest and most powerful in the body.

In the leg are the muscles which move the foot, the tendons passing

over the ankle to their attachment in the foot or on the toes. The gastrocnemius and other great calf muscles unite into a single great tendon which is attached to the heel, and is called the tendo Achillis, or tendon of Achilles, since that hero is reputed to have been invulnerable except at that point. The calf muscles enable one to rise on the toes; hence the exercise of rising on the toes produces growth in the size of the calf. The extensor muscles, on the front of the leg, turn the foot and toes upward, while the peroneus muscles, on the outside, turn the foot upward and outward.

The interstices between the ribs are filled with muscles, while the entire abdomen is enclosed by the rectus abdominalis, the obliquus externus, and other abdominal and lumbar muscles, which form a muscular pocket for containing the stomach, bowels, and other abdominal viscera. Separating the chest from the abdomen is a muscular partition, the diaphragm or midriff, which assumes a dome-like form, projecting into the chest and thus increasing the capacity of the abdomen. The fibres of this muscle are attached to the circumference of the chest and converge to a tendinous centre. When these fibres contract, then they tighten the diaphragm and reduce the amount of projection into the chest. This muscle performs an important function in connection with the act of breathing.

It has already been remarked that those muscular organs which are not under the control of the will are composed of involuntary muscular tissue, and that these include the heart, bowels, bladder, stomach, lungs, arteries, and veins.

CHAPTER VI

THE CENTRAL POWER—THE BRAIN AND NERVES

It has been stated in the preceding chapter that the muscles moving the body are subject to the control of the will. The question then logically follows, Where is the will located, and how are its wishes conveyed to the muscles? The will is located in the brain, and its volitions are carried to the muscles by the nerves.

The nervous system, consisting of the brain and nerves, is much like a great railway system. The train despatcher sits in his office surrounded by ticking telegraph instruments, by which he is kept constantly informed of the movements of a large number of trains at varying distances, on a network of

steel rails, at frequent points upon which are telegraph stations, at which his messages, sent over the wires following the tracks everywhere, are delivered to the train officials. If it is necessary to detain a train, he quickly transmits a message to it and governs all its movements. When, on the contrary, the officials of a train are uncertain as to the course to take, they telegraph back over the same wires for orders.

The office of the train despatcher is the **brain** of the railway, and he himself is the **mind** which controls and directs the workings of the trains, the **muscles**, through its **nerves**, the telegraph lines. Reversing the simile, the brain is the office of the train despatcher, that official is the mind which telegraphs its wishes over the nerves to the muscles, which move the body.

Fig. 29.—Section of the brain down the middle line.

The nervous system comprises the brain, the spinal cord, and the nerves. The **brain** is a large collection of gray cells and white fibres, situated in the dome-like cavity of the skull. It naturally divides itself into two parts, the **cerebrum** or brain, and the **cerebellum** or little brain. The former, which

appears like a gray mass of macaroni, lies in the upper and anterior part of the cranial cavity, and is by far the larger; the latter is located in the posterior and lower part of the cranium, and its surface presents a succession of parallel horizontal ridges. The cerebrum is the site of the mind, the centre of all perceptions, and the seat of the intellect and the emotions. The cerebellum contributes the harmony of movements and the property of equilibrium.

These organs are connected with the various portions of the body by means of innumerable white threads, called nerves — the telegraph lines with which the seat of the will is connected with the organs upon which it acts. From the under portion of the brain a great collection of nerves, crowded together into a single great cord, passes down through the great aperture in the bottom of the skull into the canal in the spinal column — this is the spinal cord, or "spinal marrow." It extends from the brain to the loins, a distance of about eighteen inches.

Fig. 30. — The upper surface of the brain, showing the hemispheres, the great fissure, and the convolutions.

At a point just before it passes out of the skull into the spine, the spinal cord swells out, forming an enlargement called the **medulla oblongata**. The nerves of the face and head, and also those which influence the movements of the heart and lungs, come from the medulla oblongata. For this reason, wounds at this point are extremely grave, and death inevitably follows in a very short time. Breathing and the beating of the heart are stopped by the destruction of the

nerve centres at which they originate. Small animals are often instantaneously killed for food by thrusting a needle into the medulla or by a quick blow just behind the ears, which wounds the delicate medullary substance. This is the principle upon which capital punishment by hanging is founded: the sudden drop should throw the spine out of joint with the skull and wound the medulla, producing instant death.

A number of smaller collections of nerve fibres pass directly from the brain to the organs which they supply. These are the **cranial nerves**. It is worthy of note that the higher the function of an organ, the nearer the brain does it derive its nerve supply. This is evident from the important functions accorded to the cranial nerves, from which we derive smell, sight, hearing, and taste. There are twelve cranial nerves on each side, subdividing into an immense number of branches.

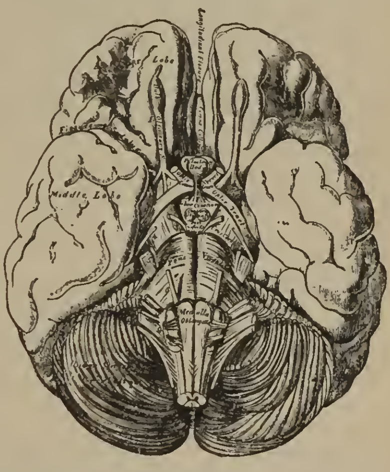

Fig. 31. — The lower surface of the brain, showing the cerebrum, cerebellum, pons Varolii, and medulla oblongata, with the great fissures, the origins of all the cranial nerves and other organs.

Out through the apertures between the vertebræ and on the sides of the spine, pass to the body the subdivisions of the spinal cord, the **spinal nerves**. There are thirty-one spinal nerves coming from each side of the spine, — sixty-two in all. These branch so as to reach all parts of the system and provide every portion of the economy with a nerve centre, a telegraph station to the brain.

There are two kinds of nerves, the motor nerves or nerves of motion, and the sensory nerves or nerves of feeling. The **motor nerve** conveys the impulse from the brain to the muscles which are to act. If a man wishes to grasp the hand of a friend, the desire is telegraphed instantaneously through the spinal cord and motor nerves to the muscles of the upper extremity, and the arm is extended and the hand clasped as desired. If he wishes to greet his friend, a similar impulse is telegraphed over the motor nerves of the face and throat, and the words of greeting are formed. Any other movement — winking, eating, walking, running, sitting, or standing — is influenced or produced in the same way.

The **sensory nerve**, acting in a direction opposite to the motor nerve, conveys impressions or sensations from an organ to the brain. The man who has clasped the hand of a friend knows that his friend has returned the greeting, because the sensory nerves in his hand perceive the pressure and flash the information to the brain through the spinal cord. The slightest touch is appreciated, and the brain informed of it with wonderful rapidity. The forms of the letters on this page make, upon the sensory nerves of sight, an impression which is conveyed to the brain, where the thought presented is appreciated. The alderman enjoys his terrapin, the florist is delighted by the odor of his flowers, the musician is charmed by sweet sounds, and the soldier feels the pain of his wounds, through sensory nerves passing from the tongue, the nostrils, the ears, and the injured part to the brain.

Certain nerves contain both motor and sensory fibres, and an impulse and a perception going in opposite directions may pass through the same nerve at the same time. These are **compound nerves.**

We know that this system of nerve telegraphy between the organs of the body exists, because when the line is cut by section of the nerve, the action or perception of the organ reached by it is lost. When the motor nerve fibres supplying a part are cut, the power of motion is lost in the part, — it is paralyzed, — and this is called motor paralysis. When the sensory fibres are divided, we have loss of sensation or sensory paralysis. We more frequently see the two varieties of paralysis combined.

The gray matter forming the outer coating and a few lumps in the centre of the brain, and the centre of the spinal cord, is composed of

very minute cells of varying shape, most of them with one or more processes, some of which are directly continuous with nerve fibres. The white substance consists (Fig. 33) of a mass of fibres composed of a central fibre, the axis cylinder, about which is a coat of fatty matter called the white substance of Schwann, and, covering the whole, a delicate membrane, the neurilemma.

The surface of the cerebrum (Figs. 30 and 31) is irregularly divided off into rounded prominences called convolutions, the deeper depres-

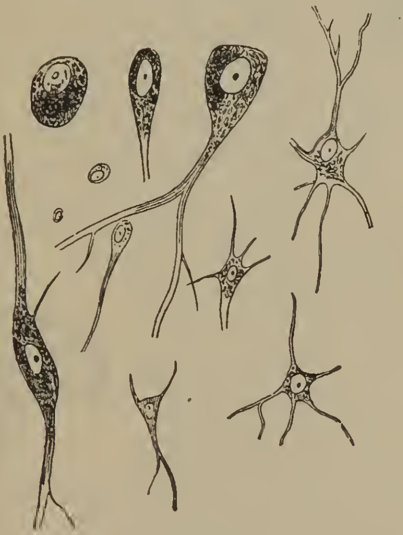

Fig. 32. — Nerve cells, from the gray matter of the brain, showing the varying number of processes and the nuclei.

sions between which are called fissures, while the more shallow are known as sulci. The cerebrum is divided by a deep fissure into two egg-shaped bodies called the right and left "hemisphere." The hemispheres are united at the bottom of the fissure by the corpus callosum, a mass of white fibres passing from one side to the other. The hemispheres are further subdivided, by other fissures, into "lobes." In each hemisphere is an irregular cavity called the right and left "ventricle" respectively, and into them project several masses of gray matter found

in the interior of the brain, from some of which originate sight and smell. There are five ventricles in the brain. Upon the base of the brain (Fig. 31) are a number of projections and depressions which have received names, as well as the origins of the twelve cranial nerves. The pituitary body is a small reddish gray ganglion, which is of interest because it was thought by the ancients to be the source of the nasal mucus, which was supposed to find its way thither in some way through the sphenoid bone.

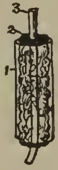

Fig. 33. — Diagram of structure of nerve fibre. 1. Neurilemma. 2. Medullary sheath, or white substance of Schwann. 3. Axis cylinder.

The gray matter of the brain seems to be the source of the intelligence, and the white substance to be merely the carrier of impulses to or from it. The intelligence increases in proportion to the amount of gray matter, which is increased in proportion to the growth in the number of convolutions, by allowing it to dip down into the sulci, which afford a more extensive surface for its accommodation. The comparatively few convolutions in children, and the still smaller number in the lower animals, then, reduces their capacity for mental action.

The pons Varolii (Fig. 31), bridge of Varolius, is a mass of nerve fibres passing from the spinal cord to the various parts of the brain and connecting them.


Fig. 34. — Diagram of human brain, showing the course of the fibres and the situation of the gray matter — the latter in black. 2, 2, 2. Hemisphere. 1, 3, 4, 5, 7, 8. Central gray ganglia. 6. Cerebellum.

In the medulla oblongata, many of the fibres of the spinal cord cross from one side to the other. It is due to this crossing or "decussation" that an injury to the right side of the brain causes paralysis of organs on the left side of the body, since a nerve starting from the right side of the brain passes down to the medulla oblongata, there crosses to the left side, and, passing down the left side of the spinal cord, emerges to the left side of the body. A nerve arising on the left side takes the opposite course.

The brain of man weighs more than that of any of the lower animals except the elephant and the whale, that of the elephant turning the scales at eight or ten pounds, while the brain of a whale seventy-five feet long weighed only a little more than five pounds. The brain of a man weighs about three pounds, and that of a woman a few ounces less. The brain increases in weight with varying rapidity from infancy to between the thirtieth and fortieth year, after which it declines at the rate of about an

ounce for each ten years. Contrary to the generally conceived opinion, the size of the brain does not appear to have any influence upon the power of the mind.

The brain is enclosed in three **membranes**: (1) Immediately next to the brain is the **pia mater**, consisting of a minute network of blood-vessels held together by fine connective tissue; it dips down into all the sulci and fissures. (2) The **arachnoid** or spider-web-like, a delicate membrane which does not dip into the grooves. (3) Outside of this is the **dura mater**, a dense fibrous membrane, which forms a strong and inextensible sac for the brain. Between the arachnoid and the pia mater is found a fluid, the cerebro-spinal fluid, affording a water cushion to lessen the effects of jar upon the brain.

The substance of the brain is exceedingly tender, and easily crushed. For this reason it is protected not only by a strong, dense membrane, but also by a case of bone — the skull-cap — which prevents contact with injurious violence. Pressure of any kind, even the most gentle, interferes with the action of the brain. When the skull is broken and the fragments press in upon the brain, paralysis in some part of the body, or loss of consciousness, or both, invariably appears. Even so gentle a pressure as that exerted by blood leaking from a small vessel is sufficient to cause insensibility, paralysis, and often death; for it is apoplexy.

Continuous with the brain are the twelve pairs of cranial nerves and the spinal cord. (1) The **olfactory nerve** contributes the sense of smell. (2) The **optic nerve** conveys the sense of sight. (3) The **motor oculi** influences the movements of the eye. (4) The **patheticus** controls the act of rolling the eye upward. (5) The **trifacial** gives feeling to the eye, face, and mouth, influences chewing, and helps to furnish the sense of taste. (6) The **abducens** makes it possible to turn the eye to the side. (7) The **facial** supplies the expression of the features. (8) The **auditory** imparts the power of hearing. (9) The **glosso-pharyngeal** contributes feeling to the throat and helps the sense of taste. (10) The **pneumogastric** gives feeling to the throat and controls the muscles of talking, breathing, and the beating of the heart. (11) The **spinal accessory** supplies motion to certain muscles of the neck. (12) The **hypoglossal** imparts the power of motion to the tongue.

The **spinal cord** is a long, rod-like mass of white nerve fibres surrounding a central mass of gray matter. The fibres communicate with the gray matter of the brain. The front of the spinal cord gives origin to motor nerve fibres, and the back of the cord gives origin to sensory fibres. When a man is struck, he feels it with the back of the spinal cord, but the front of the cord causes him to move forward, to seek safety. The front of the cord then may be diseased so that impulses can no longer be conveyed through it, while the back may be unaffected,

Fig. 35. — Diagram of the nervous system, showing the superficial nerves on the right, and the deep nerves on the left side of the body. 1. The cerebrum. 2. The cerebellum. 3, 3. The spinal cord. 4. The sciatic nerve.

in which case the sick person would be unable to move his limb, while at the same time he could feel every touch upon it. In the same way feeling may be paralyzed, while motion is not affected.

The gray cells themselves of the spinal cord have the power of originating certain unimportant acts. If the hand be accidentally brought in contact with a hot stove, it is often drawn back by a rapid convulsive motion before the pain is felt or the reason of the act is realized. In the same manner, if one loses his balance, he throws his hands out to regain it automatically, not realizing the act until it is all over. The rapid movements of the fingers of the piano-player become unconscious and automatic. These acts are unintentional and even unconscious — and dependent upon no volition of the brain. They originate in the gray cells of the spinal cord, and this is called the *reflex action of the spinal cord*.

From the sides of the spinal cord pass the nerves to the various parts of the body. Through the interstices between the cervical vertebræ passes, among others, the phrenic nerve, which passes down to the diaphragm or midriff, and is an important factor in breathing, and the **brachial plexus** which supplies the upper limb. This plexus gives off nerves to the skin and muscles of the arm, the **median** and **ulnar** to the front of the forearm, and the **musculo-spiral** and **radial** to the back of the forearm. Between the dorsal vertebræ emerge nerves to the chest and back. Between the lumbar vertebræ pass out the nerves forming the **lumbar plexus**, branches of which go to the front of the lower limb. And between the sacral vertebræ pass out the nerves which, together with the lower lumbar, form the great **sciatic nerve**, which runs down the back of the thigh and supplies the back of the lower extremity.

A knowledge of the points from which the nerves arise is a help to the diagnosis of the points at which the cord is injured in case of spinal injury. If the back of the lower limb, for example, is paralyzed and the front is not affected, we know that the lesion lies between the lumbar and sacral vertebræ. The origin of the various nerves being known minutely, the location of an injury may be very definitely located in this way in any part of the cord.

The Sympathetic System. — In connection with the involuntary muscles, we have referred to the necessity for a system which should be free from the control of the will. The involuntary muscles receive their nerve supply, not from the great cerebro-spinal system, which has been described, but from a special system, called the sympathetic system, and consisting of a double set of small collections of gray matter called ganglia, lying along the sides of the spinal column. These ganglia are mutually interconnected, and send off nerves which form plexuses, and go directly to special organs. It controls the heart and blood-vessels — a fortunate circumstance; for were they under the control of the voluntary nerves, the heart would stop when one goes to sleep. It supplies

and controls the involuntary muscles and organs of secretion and excretion. Were it not for this system, digestion would cease and breathing would be suspended. Perhaps the action of the sympathetic system may be seen most clearly in the pupil of the eye, which, without any aid from the will, invariably adapts itself to the circumstances under which it is placed: if it be dark, it dilates in order to let as much light as possible into the eye; if, on the contrary, the light be brilliant, it contracts to a mere pin point, to avoid flooding the eye with light.

While, as in the beating of the heart and the breathing, in most instances the sympathetic system acts continuously, in some others it requires some irritation to produce its action. The iris, with its changes subject to the variations of the light, is an excellent example. The contact of food with the interior of the stomach, which causes that organ to begin the churning motion needed for digestion, is another.

Mental emotions may also have a reflex action upon the sympathetic. Terror dilates the pupil, and bashfulness acts upon the nerves of the small blood-vessels of the face so as to produce blushing.

Irritation of the sympathetic nerves may in its turn have a reflex action upon the cerebro-spinal system. The convulsions of children are often due to the presence in the bowels of undigested food. The same cause has been known to make a child cross-eyed and even partially paralyzed

CHAPTER VII

THE REPAIR APPARATUS — THE BLOOD AND ITS CIRCULATION

THE human machine, like artificial machines, is affected by constant use with wearing and breakage. When the machinery of a clock becomes worn or broken, it is necessary to take it to a clock-maker and have it repaired by replacing the disabled part with a new one, or joining together the fragments. The human machinery, however, contains in itself the means of overcoming the effects of wear and tear — it is self-repairing. By this provision waste is remedied, growth is produced, and good working order is maintained.

This combined function, common to all animal bodies, is called *nourishment*. The nourishment of the body is provided by the **blood.** In addition, the blood acts as a scavenger in carrying off the waste products, a contribution to the

process of excretion which will be studied in a separate chapter.

The blood forms from one-twelfth to one-eighth of the weight of the body and is estimated at about a gallon and a half in bulk. Its presence is necessary to the continuance of life, death rapidly ensuing after great losses. The blood is a bright red color in one set of blood-vessels — the arteries — and dark red or purple in another — the veins. This color is due to the presence of microscopic **red blood-corpuscles**, which, when viewed singly, under a high magnifying power, are light yellow in color, but when aggregated together in vast numbers produce the familiar crimson hue.

Fig. 36. — Human blood-corpuscles. *a*. Red corpuscles seen flatwise; *b*. Seen edgewise; *c*. White corpuscle.

The blood is composed of red and white corpuscles floating in a liquid called the **liquor sanguinis**. The red corpuscle is a circular disc about $\frac{1}{3200}$ of an inch in diameter, and fifty million of them may be collected into a cubic line. Their number, however, is so enormous that it has been estimated that if all the red blood-corpuscles in the blood of a single individual were placed end to end in a single row, they would form a continuous line long enough to encircle the globe four times. They are hollowed out on both faces into a biconcave shape. They are soft and elastic in structure, readily resuming their form after the removal of pressure which has distorted them.

Next to water, which forms a little more than half of these bodies, their principal constituent is hæmoglobin, a compound containing iron, to which is due the red color of the corpuscles. Hæmoglobin unites readily with oxygen, and contributes the oxygen-carrying function to these corpuscles.

White blood-corpuscles or leukocytes are also present in the blood, in the proportion, in health, of but one to five hundred of the red. They are shaped much like a sphere,

are granular in appearance, and about $\frac{1}{2800}$ of an inch in diameter.

They are peculiar in the ability to exhibit spontaneous changes of shape like the amœba, an infusorial animalcule of the lowest grade of life. These movements are thence called amœboid, and consist in the protrusion of processes of the jelly-like mass composing the corpuscle, which may be drawn back and other processes protruded. By the exercise of this function, the white corpuscles under certain circumstances are enabled to penetrate through the walls of blood-vessels into the neighboring tissues. The corpuscle first throws out a slender process which it insinuates through the vessel wall and then draws the rest of its body through the opening thus made. In any severe inflammation the white corpuscles crowd to the inflamed part and, unless the inflammation is subdued very early, they congregate in the tissues and form the yellow "matter"—pus—found in abscesses or boils.

Fig. 37.— Large frog's capillary, showing white corpuscles pushing through the walls by means of amœboid motion. *a*, *a*, *a*, *a*, Cells in the act of passing through. The red corpuscles of the frog are oval, as seen in the figure.

The **liquor sanguinis** is a clear, slightly thickened yellowish fluid in which the corpuscles float. It consists of serum and the elements of **fibrin**. Fibrin is an albuminous substance which remains in solution when the blood is in motion in the body, but when the flow of blood is stopped for any reason in the vessels, or when it has been lost from the body, it appears as a network of fine fibrils which entangles the corpuscles in its meshes and forms a jelly-like mass called a blood-clot.

This process is coagulation, or clotting of the blood, and a clot may be formed in a few minutes. It first includes the serum in its substance, but this gradually separates, the clot contracting in size, until the two are entirely separate. The function of fibrin as a producer of clotting is of very great importance: if clotting did not occur, a very small cut might cause bleeding sufficient to empty the body and cause death; but in moderate cuts the clot forms quickly and, closing the

bleeding vessels, stops the bleeding. Moreover, the material which is produced for the permanent healing of the injured part contains a principle identical with fibrin, which thus exercises important healing functions.

The **serum** is liquor sanguinis from which the fibrin has been removed. It contains albumen, a substance similar to the white of an egg, fatty matters, carbonic acid, oxygen and nitrogen gases, and salts. The **salts** of the blood must not be confused with the salt used for seasoning food or with the "salts" used in medicine as a cathartic: they are substances formed by the union of a base, such as iron or lime, with an acid. Some of these salts enter into the formation of tissues, especially of bone, others are decomposed and recombined in the body, and still others are on their way to be thrown off as waste products. Certain of them also increase the absorptive power of the serum for gases. While the **fatty matters** are partly the means by which the supply of fat in the body is maintained, they also are the main source of the secretions of milk and bile, and, by their union with oxygen, assist in maintaining the warmth of the body. Of the **gases**, the oxygen is a nutritive on its way to be absorbed, and the carbonic acid is a waste product on its way to be cast off. The **albumen** goes to the nourishment of the tissues, which consist largely of modifications of it.

When, as the result of certain diseases, the serum passes out of the blood-vessels, the condition is called **dropsy**. When it is distributed through the tissues, giving them a puffed, swollen appearance, and the depression made by pressing the finger into the swelling is not promptly effaced, the condition is called œdema. When the serum collects in cavities, it receives still other names. Dropsy of the chest occurs in pleurisy, and ascites, or dropsy of the abdomen, is comparatively common.

An important function of the blood is to maintain and equalize the heat of the body, as well as to provide it with the requisite moisture for the performance of the various functions of life.

Its function as the source of the materials needed for the nourishment of the system has been noted. It is a vehicle for the reception and storage of nutriment — food, drink, and oxygen — and for its conveyance to the tissues.

It absorbs refuse matters from the tissues and conveys them to the organs provided for separating them and removing them from the body. This process is more fully discussed in connection with the apparatus for the disposal of waste.

The vehicle for the conveyance of food to and the carriage of waste from the tissues, being the blood, we naturally look for the force which moves the vehicle and the roads over which it travels. The blood is kept in perpetual movement through the body by a great stationary engine, the heart, over innumerable roads called blood-vessels.

The **heart** is a hollow conical involuntary muscle, rather larger than a man's closed fist — about five inches long and between three and four inches wide, weighing about nine ounces in woman, and eleven in man. It lies in the chest, behind the breast bone, rather more upon the left side, with

Fig. 38. — Human heart, front view. *a*. Right ventricle. *b*. Left ventricle. *c*. Right auricle. *d*. Left auricle. *e*. Pulmonary artery. *f*. Aorta.

Fig. 39. — Human heart, back view. *a*. Right ventricle. *b*. Left ventricle. *c*. Right auricle. *d*. Left auricle.

its larger end, or base, above, and its point, or apex, pointing downward and to the left. It rests upon the midriff below, and its apex during life beats against the chest wall in the space between the fifth and sixth intercostal cartilages, about two inches below the left nipple, and an inch and a half to the left of the middle line of the body. At this point the beating of the heart can readily be felt, heard, and often seen moving the chest wall as it strikes against it.

The heart, practically consisting of two conical muscles laid side by side, is usually considered as divided by a partition into two divisions which have no communication with one another. Each of these divisions contains two cavities, separated from one another by a horizontal muscular wall containing a communicating aperture. The upper cavities are called **auricles**, right and left, and the lower are known as

ventricles, right and left, and the openings between them are the auriculo-ventricular openings, right and left.

The walls of the auricles are thin and rather membranous, while those of the ventricles are thicker and muscular. The walls of the left ventricle are the thicker, and the muscle the more powerful because of the greater amount of work it has to do. Each of these chambers contains other openings, where the great vessels communicate with them. These apertures are all provided with valves which permit the blood passing through them to go in but one direction. The valve on the right side, which permits blood to pass from the right auricle to the right ventricle, but prevents its return, is called the "tricuspid" valve, because it consists of three little membranous flaps which fall over the opening and close it, being kept from falling through to the other side by a number of fine cords attached to them. The valve on the right side is called the "mitral" valve, from its supposed likeness to a bishop's mitre, and consists of two flaps which close together in the same manner as those of the tricuspid valve.

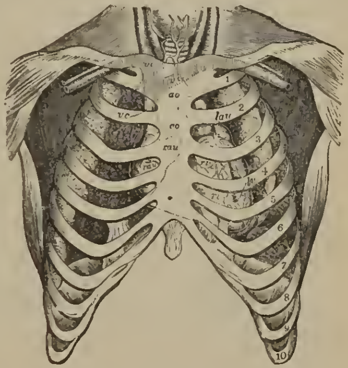

Fig. 40. — The heart, in relation to the chest walls and the lungs, the flap of the latter which partly covers it in front, having been removed. *vi.* Innominate vein. *ao.* Aorta. *v. c.* Superior vena cava. *r. au.* Right auricle. *l. au.* Left auricle. *r. v.* Right ventricle. *l. v.* Left ventricle.

The other apertures in the heart are the openings of the great blood-vessels, the veins, into the auricles, and the arteries into the ventricles. Valves are situated at these openings also, those in the auricles preventing the return of the blood into the veins, and those in the ventricles preventing the return from the arteries. The vessels all enter the heart at its base, — the upper extremity, — and the heart is suspended from the chest walls by them.

The heart is enclosed in a bell-like membranous sac, the **pericardium,** the lower end of which, in order to give room for the play of the apex of the heart, spreads out on the midriff, while the upper end is lost upon the great blood-vessels. This sac is lined with a serous membrane, which is also continued over the surface of the heart itself: serous sur-

faces are characterized by extreme smoothness, which is increased by the secretion of a lubricating fluid. This, then, makes it possible for the surfaces of the heart and pericardium to glide upon one another with the least possible amount of friction.

The **blood-vessels** are closed pipes or tubes through which the fluid blood is propelled throughout the body. They are of three kinds, — the arteries, the capillaries, and the veins.

The **arteries** are fibro-muscular tubes through which the blood is carried from the heart to the various portions of the body. They permanently retain the shape of a hollow cylinder, even when empty. They are open from end to end, presenting no valves to limit the flow of blood in them. Consequently, if one of them be cut, the blood will continue to flow from the wound until there is none left in the body, and death will follow unless it be closed.

They contain a large amount of elastic tissue in their walls, which prevents shock from the sudden influx of blood following a heart-beat, maintains an equal pressure during the interval between the heart-beats, enables the vessels to adapt themselves to any increase or diminution in the amount of blood, and also to different movements of the body. The muscular elements of the arteries regulate the amount of blood to be received by each part or organ at any given time in accordance with their needs; and when an artery is cut, the muscular elements diminish the size of the opening, in some cases even closing it, and help to check the bleeding.

Two great arteries start from the ventricles, the **pulmonary** artery from the right, and the **aorta** from the left. These break up by continual dividing into a great number of branches, constantly diminishing in size. The smallest arteries are sometimes called arterioles.

The smaller arteries freely communicate with one another by branches extending from one to another, thus constituting an arterial network. This communication is called **anastomosis**. It is a wise provision to obviate the cutting off of the blood supply and producing the death and decay of a part by the closure of the artery supplying it. The intercommunications of the arteries are especially extensive about the joints, the upper extremity, and the head. In consequence of this anastomosis, when an artery is cut, the blood flows not only from the end toward the heart, but when that is closed by any means, the blood passes around through an anastomosis and spurts out through the farther end of the

vessel. This route for the blood around an accidental closure is called the **collateral circulation**, and where it exists freely it makes it necessary to close both ends of a divided artery.

The **capillaries** are the smallest of the blood-vessels, and may be considered either as the terminations of the arteries or the beginnings of the veins, for it is impossible to ascertain the exact point at which the venules begin or the arterioles end. They form an immense network, furnishing the blood supply of the entire system, and are characterized by maintaining the same diameter from end to end, unlike other vessels, which diminish in size in one direction. They are about $\frac{1}{3000}$ of an inch in diameter, and are composed of two very delicate membranes, which do not interfere with the passage of the constituents of the blood through them into the tissues, or from the tissues into the blood. It is in these vessels that the final aim of the circulation is accomplished. Here is extracted from the blood the nutrition brought into the circulation by the arteries, and here the blood acquires the waste products which are to be carried away by the veins.

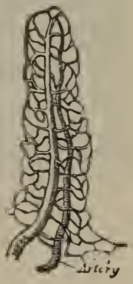

Fig. 41. — Capillary network from the bowel, showing how the capillaries connect the veins and arteries.

The **veins** are formed by the union of two or more capillaries, and continually joining together, ultimately form large trunks, just as the little brooks and streamlets join to form larger streams, and, by continually uniting, at last form the mighty river flowing down to the sea. Finally the veins unite into two great venous trunks, — the inferior vena cava, bringing the blood from the body and lower extremities, and the superior vena cava, bringing the blood from the head and the upper extremities into the right auricle. The pulmonary veins, four in number, bring the blood from the lungs to the left auricle.

Unlike the arteries, the veins collapse when empty, and enlarge when filled. This can readily be seen in the veins

in the hand and forearm, which are ordinarily small and inconspicuous, but after any exercise which tends to increase the flow of venous blood, or when the arm is tightly bound so as to delay the flow of blood toward the shoulder, the vessels become large and prominent.

Unlike the arteries, the flow of blood in which is caused by the pumping of the heart, the veins have no organ which directly forces their contents to their destination. The movement of blood through the veins is due to four causes. (1) The pressure behind of the blood pushed into the capillaries from the arteries by the heart; this is the main cause. (2) The presence of valves at frequent intervals, which prevent the backward flow of blood. This provision in veins is of great surgical importance, for the blood can only flow from the smaller end of the vein, which greatly diminishes the danger of bleeding in such injuries. (3) The pressure of muscles upon the veins presses out the blood from the veins underneath them, and, as the valves prevent its retreat, it must go forward. (4) The suction on the large veins, when, in breathing, the air is drawn into the lungs, also assists slightly in the movement of the blood.

Fig. 42. — Diagram showing a vein with the valves closed. The blood is passing off in this case by a lateral channel, as indicated by the arrow.

The blood has two distinct courses, called the pulmonic or lung circulation, and the systemic circulation. In the lungs the blood is purified, and in the system it is polluted.

Such are the various portions of the machinery by which the blood is forced through the body. The blood-vessels are simply pipes through which the blood is forced by a pump. The pump is the heart, and its mechanism is very simple. The blood having passed through the auricle into the ventricle, the muscular fibres contract and the walls of the cavity are brought together; the backward pressure closes the valve at the auriculo-ventricular opening, leaving in each side of the heart but one means of exit — the opening into the aorta in the left ventricle, and that into the pulmonary artery in the right; the blood is consequently forced into these vessels.

As the ventricle contracts, the corresponding auricle relaxes and is filled with blood. The contents of the ventricle having been expelled, it relaxes while the auricle contracts, filling it again. This contraction and relaxation of the heart muscle produces the heart-beat; it occurs in the adult about seventy-five times a minute.

The circulation of the blood is well shown in the accompanying diagram. Starting in the (1) lungs, where after its excess of carbonic acid has been cast off and its supply of oxygen has been taken on, giving the blood a bright red color, (2) it passes through the pulmonary veins into (3) the left auricle; thence through the left auriculo-ventricular opening into (4) the left ventricle, where, by the contraction of the ventricular walls, it is sent through the aortic opening into (5) the arteries. From the arteries it floods the entire body

Fig. 43. — Diagram of the circulation. 1. The lungs. 2. The pulmonary veins. 3. The left auricle. 4. The left ventricle. 5. The arteries. 6. The capillaries. 7. The veins. 8. The right auricle. 9. The right ventricle. 10. The pulmonary artery. 11. The capillaries of the liver. 12. The capillaries of the spleen. 13. The capillaries of the alimentary canal. 14. The kidneys.

by means of the great network of (6) capillaries. In the capillaries, the blood discharges its load of oxygen and other nutritious substances into the body, and takes on a load of waste carbonic acid which changes its hue to a purplish tinge. The blood, now darkened by impurities, passes on from the capillaries into (7) the veins, and thence, by a separate vein for the upper and lower extremities, into (8) the right auricle of the heart, and on into (9) the right ventricle, whence it is thrown through (10) the pulmonary artery back into (1) the lungs.

In the diagram are indicated also (11) the capillaries of the liver, (12) those of the spleen, and (13) those of the alimentary canal, which unite together to form the "portal circulation" so called, because all the blood is delivered into the vena cava through the portal vein in the abdomen. A portion of the blood also passes through (14) the kidneys, where is performed a most important excretory function which will be considered in connection with the apparatus for the disposal of waste.

It takes about half a minute for the blood to pass through this entire course. During this period all the blood in the body makes the circuit of the system.

The pulse is caused by the wave produced by throwing a mass of blood into the arteries already containing that fluid. It is the same effect as is produced by suddenly throwing a bucket of water into a quiet pool. Waves are made to travel in all directions. The blood wave, as it travels through the vessels, striking upon the elastic wall of the arteries, causes a temporary dilatation which is followed by immediate contraction — this is the pulse. The pulse can be felt in any artery, but for the sake of convenience, it is usually felt in the radial artery on the outer side of the palmar face of the wrist. The pulse wave could not be caused by the progress of the new blood thrown out from the heart, for the wave travels much faster than the blood itself; in any case, however, the difference is not more than a fraction of a second.

The pulse beat agrees in frequency with that of the heart which causes it. In adult life, the average number of pulsations in a minute is 75. In infancy it runs between 120 and 100, and in old age between 70 and 60, although in extreme old age, "second childhood," it again becomes more rapid, running between 75 and 80. The pulse of woman is usually more frequent than that of man, and it is more rapid when standing than when lying down, quicker when exercising than when quiet, and

slower in rest or in the interval between meals than when exercising mentally or physically or during digestion.

The pulse is an invaluable adjunct to the diagnosis of disease. Fever is invariably characterized by increased frequency of the pulse, the amount of quickening varying according to the variety of fever. Inflammation causes rapidity of the pulse with a hard, tense feeling added. In extreme weakness, as just before death, the pulse is very rapid and very small, so that it is called "thready." A pulse of 160 in an adult is an almost positive sign of impending death. The pulse may be normally slow in certain individuals, and an abnormally slow pulse is present in pressure on the brain and in opium poisoning. The pulse may be irregular in its beat or even intermittent. Still finer distinctions with regard to the character of the pulse are made, each one of which have their value in the diagnosis of disease.

Differences between Arteries and Veins. — Before proceeding to a consideration of the individual arteries and veins, we may with advantage briefly recite the differences between the two varieties of vessels: (1) Arteries are stiff tubes, having strong elastic walls and remaining open when empty; veins, on the contrary, are thin and flaccid, and their walls collapse after their contents have flowed out. (2) Arteries present no obstruction throughout their entire length; veins present frequent valves to prevent the backward flow of blood. (3) Arteries present a rapid flow of blood with a remittent pulsation dependent upon the heart beat; veins present a slow and steady current. (4) Many veins lie close to the surface, and where veins and arteries run together the vein is almost invariably the more superficial; the arteries lie more deeply. (5) Arteries carry blood from the heart; veins bear it toward the heart. (6) Arteries are filled with bright red blood, purified by oxygen for the nutrition of the system; veins bear a current of dark purplish blood, polluted with carbonic acid and other waste matters. This condition is reversed in the case of the pulmonary artery and vein.

The Arteries. — The **aorta** is the greatest artery in the body. Starting from the left ventricle of the heart, by an orifice closed with semilunar valves to prevent the blood flowing back into the ventricle, it passes upward on the right side of the spine; it then arches over across the spine to the left side, where it descends through the chest, perforates the midriff into the abdomen, and terminates opposite the fourth lumbar vertebra.

The **innominate** artery arises from the aorta, passes upward for from one and a half to two inches and divides into the right common carotid and right subclavian arteries.

The **common carotid** arteries arise, the right from the innominate, the left from the left side of the arch of the aorta; they pass up into the neck, one on each side of the windpipe, running along a line followed by the inner border of the sterno-cleido-mastoid muscles; at a point about an inch below the angle of the lower jaw they divide into an internal and external branch.

The **internal carotid** arteries pass from the termination of each common carotid up to the base of the skull through canals in the temporal bones and contribute to the supply of the brain and eyes.

The **external carotid** artery, not so deep as the internal, passes up the neck to the temples, giving off branches to the larynx, pharynx, tongue, scalp, ear, mouth, and nose. The **facial** branch can be felt as it passes across the lower jaw bone, about an inch in front of the angle. The **temporal** artery with its two branches, anterior and posterior, in front of each ear, can always be felt and often seen beating under the skin.

The **subclavian** artery, arising from the innominate on the right side and from the aorta on the left, passes up on each side and curves over the first rib, but under the collar bone, and again passes down to the lower edge of the first rib, where it changes its name to axillary. Lying on the first rib, it can be compressed on that bone to stop bleeding in case of a wound of one of the arteries of the upper extremity.

The **axillary** artery is then a continuation of the subclavian from the lower border of the first rib, whence it extends across the armpit into the arm, where it changes its name to brachial.

The **brachial** artery is a prolongation of the axillary, and runs down the arm along the inner edge of the biceps muscle into the forearm, about an inch below the bend of the elbow, where it divides into the radial and ulnar. Its course is approximately shown by a line extending from the middle of the armpit to the middle of the elbow. It lies on the arm bone, along the inner margin of the biceps muscle and comparatively near the surface, so that it can readily be compressed.

The **radial** artery, one of the terminal branches of the brachial, extends down the outer side of the forearm to the wrist, on a line extending from the middle of the elbow to just within the outer margin of the lower end of the radius, where it turns and, winding around the back of the thumb and between the thumb and forefinger, finds its way deeply into the palm, which it crosses, forming the **deep palmar arch** by meeting with a branch of the ulnar. Measuring off the palm in thirds and indicating them by horizontal lines drawn across it, the upper line would indicate the deep palmar arch and the lower one, near the fingers, the superficial palmar arch, to be considered presently.

The radial artery is quite superficial in the lower part of the forearm, and lies upon the radius, where its pulsation can be felt with great facility, for which reason the Pulse is usually felt at this point. The artery can also be easily compressed against the bone.

The **ulnar** artery, the larger terminal branch of the brachial, extends down the inner side of the forearm to the wrist and into the palm, where it turns and, crossing the palm and meeting a branch of the radial which passes in front of the ball of the thumb, forms the **superficial palmar arch**, which crosses the palm at the junction of its lower with its middle third.

From the palmar arches **digital** arteries pass down to all the fingers and the thumb.

As the aorta passes down the chest, it gives off a number of small branches, among which the **intercostal** arteries, ten on each side, are the most important from the standpoint of emergencies. Giving off branches running along the inner surface of the upper and lower margins of the ribs, they are likely to be implicated in injuries of the chest.

Passing then into the abdomen, great arterial branches are given off to the viscera, among which may be mentioned the **gastric** to the stomach, the **splenic** to the spleen, the **hepatic** to the liver, the **renal** to the kidneys, and the **mesenteric** to the bowels.

The **common iliac** arteries, the branches in which the aorta terminates at the level of the fourth lumbar vertebra, pass downward and outward to the brim of the pelvis, where they in turn divide into two branches, internal and external.

The **internal iliac** arteries pass into the pelvis and give off branches to the various pelvic viscera.

The **external iliac** arteries pass along the back of the pelvis in a direction indicated by a line drawn from the navel to the middle of the fold of the groin, on each side, where they pass out of the abdomen into the thigh and become the femoral arteries.

The **femoral** artery, the continuation of the external iliac in the thigh, passes down in a direction indicated by a line drawn from the middle of the fold of the groin to the inner side of the knee. The upper portion of the artery lies quite near the anterior surface of the thigh, and its pulsation can readily be felt at this point; this portion can also be compressed in case of injury below it. Its lower portion plunges into the thigh through a channel called Hunter's canal, passes through the muscles and emerges at the back of the thigh, where it receives a new name.

The **popliteal** artery — so called from the Latin word meaning ham — is a continuation of the femoral through the middle of the back of the thigh from its emergence on that face of the lower extremity to its division into two branches a little below the knee.

The **anterior tibial** artery, one of the terminal branches of the pop-

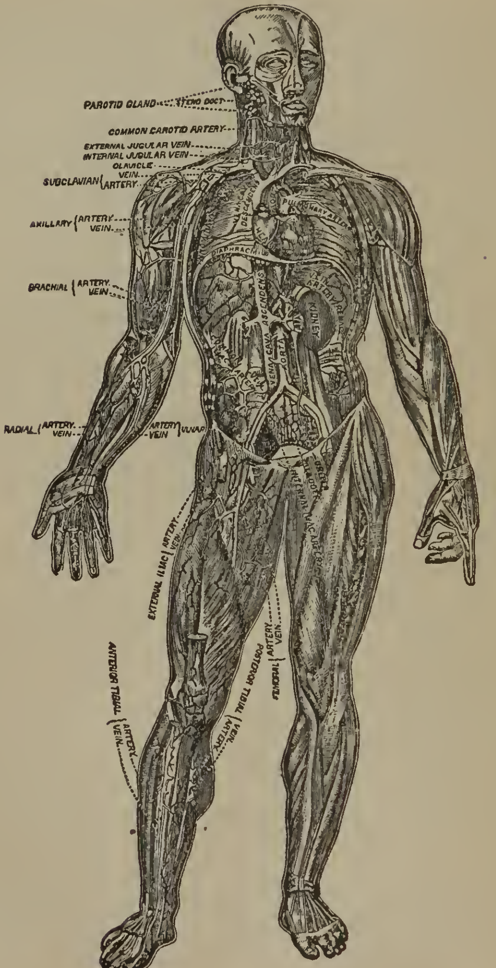

Fig. 44. — The Principal Arteries in their Relation to Other Structures.

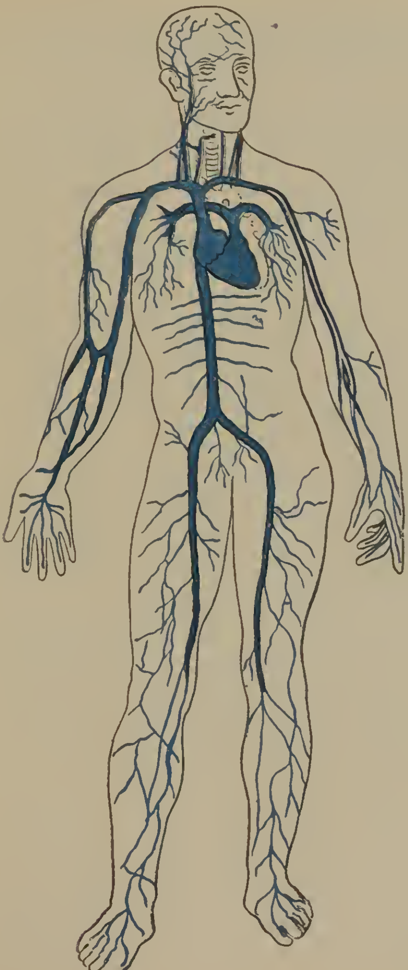

Fig. 45. — The Veins of the Body.

liteal, plunges through the leg between the two bones and passes down to the ankle, whence it passes on to the back of the foot, where it becomes the **dorsalis pedis** artery, which is distributed to the back of the foot.

The **posterior tibial** artery, the other terminal branch of the popliteal, makes its way down through the calf of the leg to the inner side of the ankle, where it curves forward about the internal maleolus into the sole of the foot and ends in the **plantar** arteries, which supply the sole of the foot. This artery lies very superficially at the ankle and can be readily felt or compressed there.

The **peroneal** artery is given off by the posterior tibial soon after its origin, and extends down the outer side of the leg to the ankle.

The Veins. — All veins carrying impure blood from the body back to the right side of the heart are called **systemic,** in contradistinction to the **pulmonary** veins, which carry pure blood from the lungs to the left side of the heart. There are four pulmonary veins, two to each lung.

It being the duty of the **systemic** veins to carry back to the heart the blood which has been brought into the system by the arteries, it is natural that the veins should return back to the heart along the same lines as the arteries took in passing out. It is found then to be the case that one or more veins run parallel to every artery. Veins are, however, especially near the surface found unaccompanied by arteries.

The systemic veins appear in two classes, the veins accompanying arteries and penetrating deeply into the tissues, and the superficial veins which run in or directly beneath the skin, where they can frequently and readily be seen.

Accompanying each of the arteries of the foot, ankle, and leg are veins known by the same name as their accompanying artery, or as the vena coma of the artery. The **anterior** and **posterior tibial** veins unite in the bend of the knee to form the **popliteal** vein which, passing through the muscles to the front of the thigh, becomes the **femoral** vein, which in turn, passing up on the inner side of the femoral artery into the abdomen, becomes the **external iliac.** The external iliac unites with the **internal iliac** to form the **common iliac** on each side, and these unite in turn to form the **inferior vena cava,** which delivers the blood into the right auricle.

Into the vena cava in the abdomen also empty the **hepatic** vein from the liver, and the renal veins from the kidneys, the latter having removed from the blood passing through it the waste matter properly excreted there. The hepatic vein carries the blood from the liver, into which enters the **portal vein** formed by the union of the **mesenteric, splenic,** and **gastric** veins, collecting the blood from the organs concerned in digestion. This vessel subdivides in the liver substance to capillaries in which the blood, containing matter from the digestive organs, under-

goes certain changes before passing out into the general circulation through the hepatic vein. It will be observed that the liver contains two systems of veins, one the nutritive veins of the gland itself, and the other the digestive vessels.

Of the superficial veins of the lower extremity, two are particularly prominent. The **internal saphenous** vein collects the blood from the superficial parts on the inner side of the back of the foot, and passes up the inner side of the lower limb, receiving, on its way, contributions from numerous tributary veins. Arrived at a point just below the fold of the groin, it dips down through a special opening in the fascia of the thigh, to enter the femoral vein.

The **external saphenous** vein, from a similar origin on the outer side of the foot, passes up the middle of the back of the leg and empties into the popliteal vein just below the bend of the knee.

The small veins of the hand unite into the **deep radial** and **ulnar,** which in turn unite just below the elbow to form the **brachials,** and these become successively the **axillary** and the **subclavian,** each of them following the course of the arteries of the same name.

The superficial veins of the palmar face of the forearm are very conspicuous and curious in their arrangement. The **median** vein passes up the middle of the forearm, and just below the bend of the elbow it divides into two branches, the **median basilic** and the **median cephalic,** which form a V in front of the elbow. These veins are joined just above the bend of the elbow by the **radial** and **ulnar** veins on either side, which changes the V in front of the elbow to an M. The ulnar and the median basilic unite to form the **basilic,** which a short distance above the elbow enters into the brachial. The radial and the median cephalic unite to form the **cephalic,** which passes up the outer side of the arm to the shoulder, where it dips down between the shoulder and the pectoral muscles to enter the axillary.

In the days of bloodletting, these veins were the favorite sites for that operation. The median basilic is the larger, but on account of its crossing the brachial artery, which is liable to be wounded, the median cephalic was often chosen. These veins can readily be shown by tightly bandaging the arm above the elbow, when, the progress of the blood to the heart being checked, the veins below the bandage will swell and become prominent under the skin.

The **external jugular** vein collects the blood from each side of the face and the superficial portions of the head and neck, and passes down the side of the neck to empty into the subclavian vein. These large veins can often be seen prominently projecting in the neck. They are the vessels usually cut by suicides in "cutting the throat."

The **internal jugular** veins collect the blood from either side of the brain, and passing down by the side of the carotid artery, receiving by the way veins from the neck and head, join with the subclavian to form the common trunk, the innominate.

At the junction of the left subclavian and internal jugular veins, the **thoracic duct,** containing the food digested in the alimentary canal, empties its contents into the blood. At the same point on the right side the right lymphatic duct enters the veins.

The **innominate** veins, on either side, formed by the junction of the subclavian and internal jugular veins, unite on the left side of the spine just below the first costal cartilage to form the **superior vena cava,** which carries the blood into the right auricle.

Vascular Glands. — The **spleen** is an oval glandular organ, five inches long by three wide and two thick, situated on the right side of the abdomen, presenting no duct, having no secretion, and connected with other organs only by the arteries which enter and the veins which pass out of it. Just what its functions may be is unknown. Its removal does not seem to affect the system in any evident way. It is thought by some to be the organ in which red blood-corpuscles are manufactured from the white, and that it also presides over the disintegration of the red corpuscles when they are worn out. By others it is considered to be a safety valve for the blood supplying the digestive organs. During the act of digestion these organs demand a much greater blood supply than when at rest, and it is thought that the surplus blood in the latter case is stored up in the spleen. In chronic malarial affections the spleen often becomes greatly enlarged, and is then vulgarly known as "ague cake."

In the neck, just below the chin and in front and on either side of the upper part of the windpipe, is another gland possessing no duct, producing no secretion, and connected with other parts only by its blood-vessels, — this is the **thyroid gland** or "throat sweetbread." This, too, is thought to have something to do with the formation and destruction of the blood corpuscles, but its function is not known positively. It is this gland, become greatly enlarged, which forms the tumor in front of the neck in "goitre."

CHAPTER VIII

THE SPEAKING AND BREATHING APPARATUS — THE LARYNX AND THE LUNGS

From the posterior portion of the cavities of the mouth and nose is suspended a combination of two organs which greatly resembles an inverted hollow tree. The trunk of the tree is formed by the larynx or organ of speech and the trachea or windpipe; the trachea divides into two branches

called bronchi or bronchial tubes, and these in turn divide — the process of division keeping on until it finally terminates in very minute tubes or pouches, called the pulmonary vesicles, and these vesicles taken together form the lungs or, as the butchers call them, the "lights."

Looking into the mouth, an arch will be seen at its back part, and this arch marks the end of the mouth proper. A similar condition exists at the posterior part of the nose. And the cavity into which both the nose and the mouth open is called the **pharynx.** In its lower portion are two apertures, that of the larynx in front and that of the œsophagus or "gullet" behind.

The **larynx,** the enlarged upper part of the trachea or windpipe, is a short, irregularly shaped tube, in which is located the organ of speech. At its upper limit is a cover composed of cartilage, which closes the air passage when food is swallowed. At the moment of swallowing, the larynx is drawn up against this cover, the **epiglottis,** and the cavity is completely closed, so that, although the food passes directly over it, none can enter. The accidental lifting of the epiglottis during the act of swallowing, as sometimes occurs during laughter, allows food to enter the larynx, and the effort to expel it produces the choking and coughing always seen at that time.

The larynx can be felt from the outside in front of the neck, where it appears as a hard lump just under the chin, known as "Adam's apple," from an old story that it was a portion of the forbidden fruit swallowed by the common ancestor of humanity, but which "stuck in his throat." It is composed of a number of cartilages bound together by ligaments, and moved upon one another by muscles. It is about an inch and a half long and an inch in diameter.

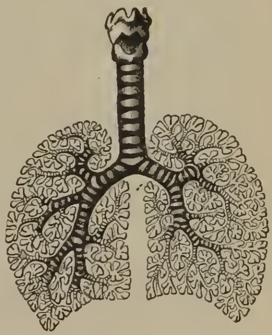

Fig. 46. — Diagram of human larynx, trachea, bronchi, and lungs, showing the ramification of the bronchi, and tne division of the lungs into lobules.

Inside of the larynx are two narrow fibrous bands extending across it from front to back: these are called the **vocal cords,** and they are relaxed or tightened by the laryngeal muscles moving the cartilages. The vibration of the vocal cords, caused by the air passing over them from the lungs, produces the voice.

The larynx is constructed on the principle of a reed organ. It contains but one pipe, but that one is susceptible of such adjustment that no others are necessary. The vocal cords are the reeds.

The larynx is continuous below with the **trachea** or windpipe, a tube composed of rings of cartilage, incomplete behind, and of elastic fibrous membrane. These rings keep the tube constantly open, and prevent interference with the passage of air by the collapse of the windpipe. The trachea is from three-quarters of an inch to an inch in diameter, and extends down the middle of the neck for four or four and a half inches into the chest, where, opposite the third dorsal vertebra, it divides into the right and left bronchi, one for each lung.

The **bronchi,** constructed in exactly the same manner as the trachea, continue branching by dividing and subdividing to the terminal lobules of the lung. The rings, as the bronchi decrease in size, become scarcer and more irregular until they are but mere flakes of cartilage, and when the tubes are reduced to a diameter of one-fortieth of an inch, they disappear entirely. The tubes, however, still continue branching until the walls consist of but a thin elastic membrane, which expands into a little sac or lobule (Fig. 48), the walls of which are pouched out irregularly into little pockets called air vesicles or cells. The air passages are lined with mucous membrane, presenting upon its surface epithelial cells covered with cilia or hair-like processes, which by a continual waving motion carry off mucous and other secretions.

The **lungs** or "lights" thus formed are two in number, one in each side of the chest. The fact of their substance consisting of air cells, with elastic walls, gives them a light, spongy appearance and feeling. They are covered externally by a smooth serous membrane, the pleura, which also lines the inner walls of the chest, providing smooth surfaces to avoid friction in the movements of the lungs in breathing. Although these two pleural surfaces are ordinarily in so close contact as to leave no vacancy between them, the cavity which may be formed is called the pleural cavity. When these membranes become inflamed, we have pleurisy, and the dropsical secretion which is then thrown out makes the cavity between the two pleural surfaces apparent.

Between the lungs lie the heart in the pericardium, the œsophagus or "gullet," the large bronchi, and the great vessels. Below the lungs lies the dome-like diaphragm or midriff, a most important factor in breathing.

The **pulmonary veins and arteries** penetrate to the substance of the lungs with the bronchi, dividing and subdividing with them until, in the walls of the ultimate divisions, the air cells are found in the **capillaries** of the lungs. Between the blood in the capillaries and the air in the air vesicles, nothing intervenes except the thin walls of the vessels and the vesicles, so that it is possible for the blood readily to cast off its carbonic acid and other impurities into the air of the

lungs, and absorb from it the supply of oxygen needed for the nutrition of the system. The enormous extent of the walls of the air cells is evident when it is considered that the capillaries contained in them must be able to contain a quantity of blood equal to that contained in the capillaries of all the rest of the body taken together. It has been estimated that the surface afforded by them is equal to more than ten thousand square inches. How vast the number of these cells is, may be inferred from this fact.

Fig. 47. — Lobule of lung. *aa*. Exterior of lobules. *bb*. Vesicles of lung. *cc*. Smallest bronchi.

Breathing or **respiration** consists of the alternate enlargement and contraction of the chest, by means of which air is drawn into or forced out of the lungs. Breathing air *into* the lungs is called *in*spiration, and expelling it *from* the lungs is called *ex*piration.

The chief agent in breathing is the diaphragm or midriff, the great dome-like muscular floor of the chest, which, when its fibres contract, flattens down the dome, increasing the amount of space in the chest, and at the same time causing the abdomen beneath it to swell out. In addition to this, the capacity of the chest is further increased by the muscles which draw the ribs upward and outward. These acts create a vacancy in the chest, which is filled by the air rushing through the windpipe into the air cells of the lungs. This is **inspiration.**

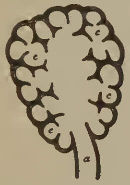

Fig. 48. — Section of a single lobule of human lung. *a*. Ultimate bronchial tube. *b*. Cavity of lobule. *c*, *c*, *c*. Pulmonary cells or vesicles.

Expiration, or breathing out, is a much more simple act, and consists simply in the relaxation of the muscles causing inspiration, — the diaphragm resumes its dome-like projection into the chest, the ribs drop to their original position, and the elastic lungs contract to adapt themselves to the reduced capacity of the chest.

These movements occur from fifteen to eighteen times a minute in health.

In case of an obstruction in the windpipe, or any other interference with the free entrance and exit of air, the breathing is much more difficult, and in this case most of the muscles of the chest, neck, and shoulders, and some on the back, join with the muscles named in the effort to expand the chest — the act then being called **forced respiration.**

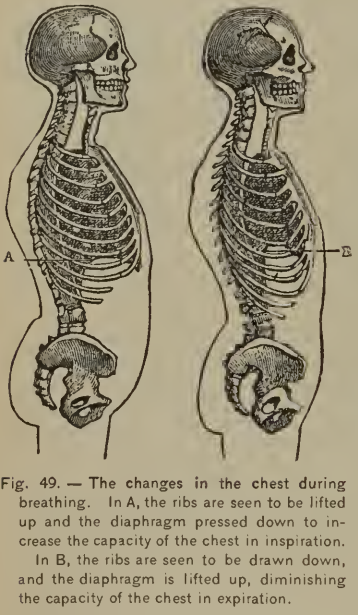

Fig. 49. — The changes in the chest during breathing. In A, the ribs are seen to be lifted up and the diaphragm pressed down to increase the capacity of the chest in inspiration. In B, the ribs are seen to be drawn down, and the diaphragm is lifted up, diminishing the capacity of the chest in expiration.

There are a number of common acts closely allied to breathing which it may be interesting to consider here. **Sighing** consists of a prolonged and almost noiseless inspiration, followed by a sudden noisy expiration, due to the elastic recoil of the lungs and chest walls.

In **hiccup** the inspiration is sudden, from the spasmodic action of the diaphragm, causing the air to rush suddenly through the larynx and produce the peculiar sound.

Coughing consists first of an inspiration and then, when the lungs have been filled, the air is not immediately let out through the larynx, which is momentarily closed so that the abdominal muscles strongly act in pushing the viscera up against the diaphragm, and increase the pressure on the air in the lungs, until the tension is sufficient to overcome the spasmodic closure which opposes its passage. This makes it possible to drive a stream of air with considerable force upon any mass of mucus or other obstructing matter and expel it.

Sneezing is similar to coughing, except that the force of the expiratory act is spent on the nostrils.

Speaking has already been referred to; it should be observed that the vocal cords produce the sounds only, and that the words are formed by the tongue, teeth, lips, and palate.

Singing is a modification of speaking, the key being altered by variations in the tension of the vocal cords.

Sobbing, laughing, and yawning are still other modifications of the act of breathing.

In each respiratory act, during ordinary breathing, from twenty-five to thirty cubic inches of air are drawn in and expelled from the lungs. This quantity of air, constantly flowing in and out, is known as the **tidal air**. But much more than this quantity can be drawn into the chest. After an ordinary inspiration, about a hundred cubic inches of air can be drawn into the lungs in addition to that already there; this is the **complemental air**. On the contrary, after an ordinary expiration, about a hundred cubic inches of air can be expelled from the lungs by a forcible expiration, and this is the **reserve air**. But after every effort has been made to empty the air cells, there still remains a quantity of air equal to about a hundred cubic inches; this is the **residual air**. The amount of air which can be forcibly expired after taking the deepest possible inspiration, is the **vital capacity**, and, including the tidal, complemental, and reserve air, amounts to about 225 cubic inches.

The complemental and reserve air are drawn upon in running, rowing, or other violent exercise, at which time the full vital capacity of the lungs is often employed.

The air which we inspire contains seventy-nine parts of nitrogen and twenty-one parts of oxygen, with a mere trace of carbonic acid and other matters of animal or vegetable origin. When, however, it is returned to the atmosphere by *ex*piration, its composition has been changed. None of the nitrogen has been lost — indeed, it rather gains in amount; but five parts of the oxygen have been lost, while the carbonic acid has increased by four and a half parts. Light as are these two gases, a man ordinarily throws out in the breath more than two pounds of carbonic acid a day, and consumes in the lungs a trifle less of oxygen. A large quantity of water and some animal matter are also thrown out from the lungs.

The blood coming into the lungs from the body is laden with carbonic acid to be expelled there. This gas, when breathed in large quantities, is a fatal poison.

Oxygen in the air that is breathed is an absolute necessity, and its absence for but a short period will cause rapid death. In a tightly closed room the oxygen of the air may be used up by repeatedly breathing it until, unless there is some means of renewing the supply, smothering will close life just as surely as if a pillow were pressed tightly over the face. The chinks about the doors and windows often allow the

passage of sufficient fresh air into a room to prevent death, while at the same time not admitting enough to fully supply the demands of the system for oxygen; headache, languor, and unaccountable weakness result from this partial smothering. It must be admitted, however, that the disagreeable sensations are probably due also to some extent to breathing again the decaying animal matters thrown out in small quantities in each breath. The continual breathing of impure air with an insufficient supply of oxygen has a deleterious effect upon the health, and many deaths have been hastened if not directly produced by it.

This is the reason why ventilation or the supply of ample quantities of fresh air has been so strongly dwelt upon by physicians and sanitarians; and why the medical man insists so earnestly upon the desirability of providing sleeping and living rooms with suitable ventilators, and with ample means for keeping them open.

CHAPTER IX

THE DIGESTIVE APPARATUS — THE ALIMENTARY CANAL AND ITS APPENDAGES

THE digestive apparatus is that portion of the human machine in which material destined to repair the wear and tear is worked up into a condition suitable for its purpose. The process by which the oxygen of the air has been conveyed into the system through the lungs has been described, and it remains to refer briefly to the manner in which other materials are adapted to the nutritive process.

The forms in which foods are absorbed are four in number: (1) Nitrogenous matter, of which the egg is a perfect example. (2) Fats. (3) Sugar; and (4) metals. All these are present at the same time in some articles of food, such as milk, while others may contain but one or two. The object of digestion, then, is to convert these four varieties of food

into a form suitable for introduction into the blood, and carriage to the system by it.

The first step in the process of digestion occurs in the mouth. Here the food is chewed by the teeth into a mass of fine particles, each of which can readily be reached by the digestive juices. The teeth have been fully described in connection with the anatomy of the jaws. They are assisted in their work by the tongue, a large, free, muscular organ, which keeps the food between the teeth during the act of chewing, and forms it into a mass of a shape suitable for swallowing.

Opening into the mouth are three pairs of glands like minute bunches of grapes, which also contribute to digestion. They secrete the saliva or "spittle." The parotid glands lie just below the temples on either side; their location will be remembered by every one when it is recalled that it is the inflammation and swelling of these glands which causes the "mumps." Under the lower jaw and at the root of the tongue are other salivary glands, the submaxillary and sublingual glands. Chewing the food mixes it with saliva, which not only lubricates the mass and makes it easy to swallow, but changes a portion of the starches it contains into sugar. Bread, beans, corn, or wheat cannot be absorbed without change; the starch, of which they chiefly consist, must first be transformed into sugar.

Up to this point the food has been under the control of the will, but now it is pushed by the tongue back into the pharynx, over the epiglottis, where it is seized by the pharyngeal muscles and passed into the œsophagus or "gullet," and the will can control it no longer. A knowledge of this fact is sometimes useful in administering pills to children or animals; if the mouth be opened and the pill be pushed back to the root of the tongue, it passes beyond the child's control and into the stomach. A mouthful of water swallowed immediately after will help to carry it into the stomach.

The **alimentary canal** is a musculo-membranous tube from twenty to thirty feet in length, with a diameter varying at different points, receiving ducts connecting it with certain accessory organs, and bearing different names in its different parts.

The **œsophagus** or gullet, the first division of the alimentary canal, runs behind the windpipe and the heart, in front of the spine and between the lungs, through the neck and chest, perforates the diaphragm or midriff, and ends in an expansion of the canal, called the stomach. It is about ten or eleven inches long from the pharynx opposite the fifth cervical vertebra to the stomach opposite the ninth dorsal vertebra. Its muscular coat is composed of involuntary fibres so arranged as to carry the food downwards. When not dilated by food, it is collapsed.

The **stomach** (Fig. 50) is the most dilated portion of the alimentary canal, and it is the principal organ of digestion. It appears in the form

of an irregularly conical bag with tubes opening into either end, and lies chiefly on the left side of the abdomen, under the diaphragm, and protected by the lower ribs. Its size is subject to greater variations than any other organ in the body, according as it is full or empty, and according to individuals; but it averages twelve inches long and four in diameter, with an average capacity of about four pints. The œsophagus enters at the larger extremity, and its opening is called the **cardiac orifice**, from its proximity to the heart; its other opening, connecting it with the small intestine, is called the **pyloric orifice**, and is guarded by a sort of valve, the **pylorus** or "gate keeper."

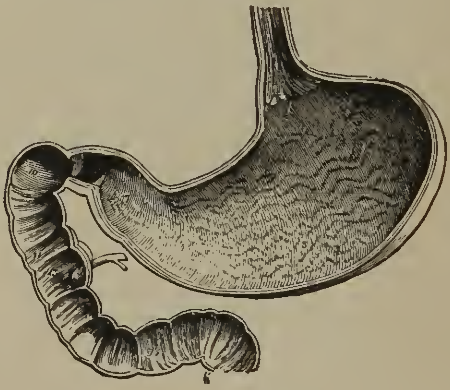

Fig. 50. — A section of the stomach and upper bowel, showing the internal arrangement, the location of the hepatic and pancreatic ducts from the liver and pancreas respectively, and the valvulæ conniventes.

The walls of the stomach are formed (*a*) by an external smooth serous coat, derived from the peritoneum, the general lining of the abdomen; (*b*) two muscular coats extending horizontally and perpendicularly, and by their contractions producing the peculiar movements of the organ; (*c*) an internal lining of mucous membrane continuous with that of the intestine below and, through the œsophagus, with that of the mouth above. In the mucous membrane are found a multitude of glands which, when food comes into the stomach, pour forth the **gastric juice**, a sour liquid which acts upon the food in the stomach and continues the process of digestion. So long as any food remains in the stomach, the muscles keep up a churning movement which thoroughly mixes the contents with the gastric juice, and greatly aids the digestion.

A small part of the food is completely digested here and absorbed into the blood in the capillaries of the stomach; the remainder is converted into a thick, whitish fluid called chyme, which passes on into the small intestine, where it is acted upon by other agents.

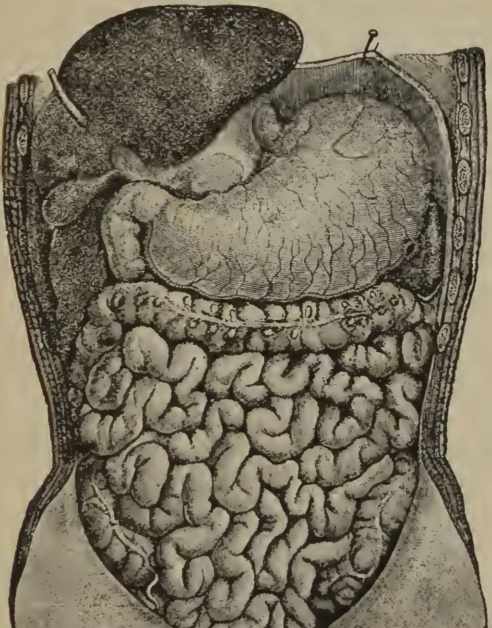

Fig. 51. — The contents of the abdomen. The liver is shown at the top, drawn up so as to show the gall bladder underneath. The stomach is seen on the right with the duodenum passing out from it. Crossing the abdomen just below the stomach is the large intestine, which may be traced up the right side of the body, across, and down the left side. In the centre is seen the small intestine gathered into a twisted mass.

At the pyloric end of the stomach, and under the left end of the liver, the alimentary canal contracts again into a slender tube called the **small**

intestine, bowel, or gut. About one inch in diameter and twenty feet long, it is attached to the lumbar portion of the spine by a membrane called the **mesentery,** which is disposed in numerous folds to adapt itself to the turns of the intestine, which is rolled into a mass suitable to lie in the cavity of the abdomen. The small intestine is divided by anatomists into three parts: the first eight or ten inches is known as the **duodenum**; the two fifths following is called the **jejunum**, from the Latin word meaning empty, because it is usually found empty after death; the remaining three fifths is known as the **ileum**, from the Greek word meaning to twist, because of the numerous folds into which it is thrown. The small intestine presents a serous, a muscular, and a mucous coat. The mucous coat presents numerous folds called **valvulæ conniventes** (Fig. 50), which greatly increase the amount of surface coming into contact with the food. It also presents an immense number of little projections called **villi,** which give it a velvety appearance: through the villi the digested food passes into the blood. A number of glands are also found producing a fluid, the "succus entericus," which promotes digestion. Into the small intestine open ducts from the liver and pancreas (Fig. 50), giving passage to fluids fulfilling a most important function in digestion.

There are two important glands which pour into the small intestine fluids essential to digestion: these are the liver and pancreas. The **liver** is the largest gland, and indeed the largest single organ, in the body, weighing three or four pounds, and measuring ten or twelve inches in breadth, six or seven in thickness, and two or three in depth. It lies on the right side of the abdomen, and is slung by its ligaments high up against the diaphragm and under the lower ribs. It is a large, reddish brown organ, marked by a number of fissures dividing it into lobes, in one of which lies a membranous bag, the gall bladder, in which is held in reserve a quantity of the secretion of the liver. It is connected with the small intestine by the portal vein, which collects the blood from the bowels, and by the gall duct, which carries its secretion into them. The liver has two chief functions: (1) It produces the bile, a yellowish brown fluid of an intensely bitter taste, which (*a*) assists in converting the contents of the small intestine into a form suitable for absorption

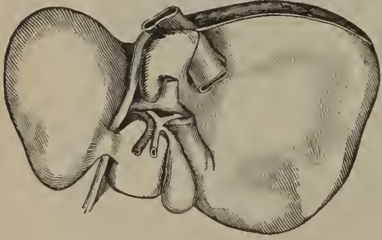

Fig. 52. — The liver seen from below.

into the blood, and (*b*) acts as a stimulant to the muscles of the bowel, thus producing some cathartic action. (2) It completes the digestion of certain portions of the food already absorbed into the blood, and produces sugar, the burning of which aids in maintaining the heat of the body.

The **pancreas,** which derives its name from the Greek words meaning "all-flesh," is known to butchers as the "belly sweetbread," in distinction from the thyroid gland or "throat sweetbread," and the thymus gland or "breast sweetbread." It is a tongue-like mass lying across the back of the abdomen with its smaller extremity or "tail" on the left, is six or eight inches long, and from a half an inch to an inch thick. From its larger end passes out the pancreatic duct, which joins with the bile duct from the liver and enters the small intestine. The **pancreatic juice** completes the digestion of the digestible portions left untouched by the other fluids, but its chief function is the division of fats and oils into particles sufficiently minute to permit of absorption into the blood. The digested food is now a milky fluid called chyle.

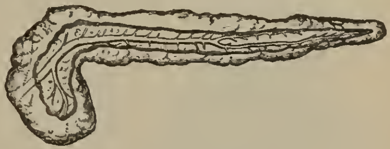

Fig. 53. — The pancreas.

The process of digestion, then, begun by finely dividing the food and converting a part of the starch into sugar in the mouth, is continued by the churning movement and the mixture with the gastric juice in the stomach, converting the food into chyme. The chyme, in the small intestine, mixes with the bile and the pancreatic and intestinal juices, which convert it into chyle. Certain portions of the digested food are absorbed into the circulation by the veins of the stomach, and others pass through the veins of the mesentery and the portal vein into the liver, while still others are absorbed by a set of vessels called **lacteal** from their milky white appearance when full of chyle, and which pass from the villi of the intestine into the mesentery and through small glands also in the substance of the mesentery, into the thoracic duct, which empties them into the left innominate vein, whence they pass into the general circulation.

The small intestine, just above the right groin, runs into the **large intestine** (Fig. 51), which, about five feet in length and thrice the size of the lesser bowel, passes up to about the level of the "navel," arches across the abdomen, and descends on the other side, where, passing to the middle line, it descends and opens on the external surface of the body. A valve — the ileo-cæcal valve — at the junction of the small with the large intestine prevents the return of matter which has passed

into the latter. A dilated pocket at the beginning of the large intestine is called the **cæcum**, and from it passes a worm-like process called the appendix vermiformis, the function of which is unknown, but which is of great surgical interest from its liability to become inflamed and produce an abscess which is exceedingly dangerous to life. The remainder of the large intestine, except the last six or eight inches, is called the **colon**. The last portion is called the **rectum**, and terminates externally in the anus or fundament. But little if any digestive action goes on in the large intestine, the principal work of which is absorption. As its contents approach its lower extremity, they become more and more solid and free from nourishment, until finally only the waste matter is left, in the form of excrement, which is thrown off.

CHAPTER X

THE APPARATUS FOR THE DISPOSAL OF WASTE — THE EXCRETORY APPARATUS

A CONSIDERABLE amount of matter is introduced into the alimentary canal which cannot be utilized for the nourishment of the system, and the various operations of the human machine cause parts to be worn away which, in the process of repair, are replaced by new ones and thrown off. This process of casting off useless, worn, or waste matters from the body is called **excretion**.

Excretion is accomplished through the skin, the lungs, the rectum, and the kidneys with the bladder.

In the **skin**, which has been described in the chapter devoted to it, are millions of glands through which water is extracted from the blood and thrown off — the sweat glands, producing the perspiration. The evaporation of the perspiration is an important provision for keeping the surface of the body cool, and is the original utilization of the principle which the soldier adopts when he wets the canvas cover of his canteen in hot weather to cool its contents. Perspiring is constantly going on, although it is imperceptible except during unusual physical exercise or great heat, when the sweat is poured out faster than it can be removed by evaporation, and it stands out in drops upon the skin. When perspiration is unusually abundant, the amount of water excreted by the kidneys is diminished. In addition to the water, the perspiration

carries out of the system salt, — which can readily be appreciated by the taste, — carbonic acid, a poisonous exhalation called urea, and other noxious substances. In case of extensive injuries, such as burns, where a considerable extent of the skin is injured so that its excretory functions cannot be exercised, and the blood relieved of the impurities collecting there, serious and often fatal results may follow.

The **lungs**, which have been considered in the chapter on the breathing and speaking apparatus, throw off more than two pounds of carbonic acid a day, a little less than a pint of water, and about three grains of decaying animal matter and ammonia.

Reference to the **rectum** has been made in the preceding chapter in connection with the large intestine. As the food taken through the lips passes down the alimentary canal, it comes in contact with various juices which prepare the nourishing parts of it for absorption, and these portions are gradually passed into the blood at points throughout the stomach and bowels until, when it arrives in the lower bowel, only the refuse matter which cannot be utilized is left. This takes the form of excrement and is cast off.

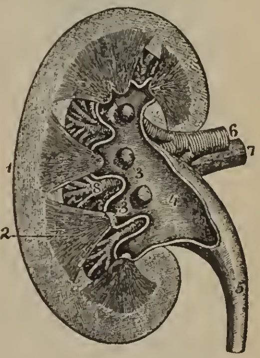

Fig. 54. — A kidney divided lengthwise. 1. The cortex. 2. Pyramids of urinary tubes. 3, 3. Apex of pyramids. 4. Pelvis of the kidney. 5. Ureter. 6. Renal artery. 7. Renal vein. 8. Small vessels in the kidney.

The **kidneys** are two glandular organs situated in the loins on the posterior wall of the abdomen on either side of the spinal column. They are shaped like large beans, and are about four inches long, two and a half broad, and an inch and a half thick; they weigh about a quarter of a pound each. They are composed chiefly of arteries, veins, and urinary tubes, and these are combined in such a way as to produce a cortex or bark-like substance and a medullary or central substance. The arteries are larger than the veins, so that a greater bulk of blood is brought into the kidneys than is carried away from them; the bulk is reduced by the passage of a portion of the water with certain waste products, notably urea, into the urinary tubules. The extremity of each urinary tubule is expanded into a sac (Fig. 55), into which a small arterial twig runs and is subdivided and turned and twisted upon itself, until it passes into a minute venous tube of a somewhat smaller size; the blood then being pushed through into the vein, the water is forced out

through the walls of the small vessels into the enclosing sac and carried off by the urinary tubule. The sacs with the intertwined vessels are called malpighian tufts. These tufts form the principal portion of the cortical substance of the kidney. Besides the water removed from the blood in the kidneys, a considerable number of chemical salts are excreted with it, and some waste animal compounds, particularly urea, a noxious substance referred to in connection with the perspiration. The fluid thus formed of water, salts, and animal compounds is a yellowish liquid known as urine.

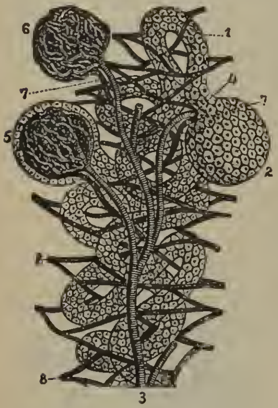

Fig. 55. — Greatly enlarged diagram, showing the arrangement of the parts of the kidney. 1. Urinary tubules. 2. Malpighian tuft. 3. Artery. 4. Artery entering the tuft. 5, 6. Malpighian tuft, with the sac removed. 7, 7, Veins emerging from the tufts. 8, 8. Veins.

The urinary tubes pass down to a cavity at what corresponds to the hilus of the bean, and is called the pelvis of the kidney, from which passes out a tube about the size of a goose quill, and runs down along the back to the bladder: this is the **ureter**, and its function is to carry the urine from the kidneys to the bladder. A little more than three pints of urine is formed during a day.

The urinary **bladder** is a bag formed of involuntary muscle and membranes, lying in the cavity of the pelvis. Its function is to store the fluid continually secreted by the kidneys until such time as is convenient to discharge it. When moderately distended, it contains about a pint, and is oval in form, measuring about five inches in height and three in breadth. In the bladder chemical salts may settle and form a hard deposit, which increases in size until it resembles a veritable stone: this is "stone in the bladder." The act of discharging the contents of the bladder is under the control of the will, and occurs several times a day.

CHAPTER XI

THE PERCEPTIVE APPARATUS — THE SENSES

THE senses are the portals of the intelligence; for through them all perceptions find their way to the seat of the intelligence in the brain. They comprise touch, taste, smell, hearing, and sight.

The sense of **touch** and its relation with the brain through the sensory nerve filaments distributed throughout the body has been described in connection with the nerves. In the sense of touch is also included the appreciation of heat and cold. In connection with the bones reference has been made to the wonderful mechanism of the hand. A great portion of the usefulness of that member is due to the sense of touch, which is most highly developed on the palmar face, and in particular at the tips of the fingers.

The sense of **taste**, situated in the cavity of the mouth, consists in the perception of the flavor of articles, particularly in their relation to food. A sweet, a sour, a bitter, or a saltish taste is understood by every one. Dependent upon taste is the appetite. The study of the gratification of the taste has been the life work of not a few, and the art of cookery — the preparation of food in such a manner as to gratify the taste — is a vocation well worthy the attention of a higher grade of mind than is wont to be devoted to it.

The adaptation of food to the taste has a hygienic value; for experience has shown that, as a general rule, the most savory food is the most easily digested. There seems to be a correlation between the sense of taste and that of sight as referred to the perception of colors, although the former has not been developed to the same extent as the latter. There should be considered, in cooking, a harmony of savors, in order to attain full palatability, just as in painting a harmonious combination of colors is needed to please the eye.

The sense of taste is most highly developed in the *tongue*, and the full advantage of the sense is obtained only after the food has been passed back over the tongue to the pharynx. The object to be tasted

must be moistened in order to make its impression upon the nerves of this sense. The perception of taste is carried to the brain by a branch of the trifacial and by the glosso-pharyngeal, both cranial nerves, the latter supplying the back of the tongue, and the former the tip.

Upon the top of the tongue toward the back are seen eight or ten minute prominences arranged in the form of a V: these are the circumvallate papillæ, and contain the terminations of the filaments of the glosso-pharyngeal nerves. Along the sides and tip are a number of smaller prominences called the fungiform papillæ, containing the terminations of the lingual branch of the trifacial nerve. A third set, called the filiform papillæ, are distributed over the tongue, but are probably not involved at all in the sense of taste. The back portion of the tongue perceives taste the best, although the tip more quickly appreciates sweet and pungent savors, the bitter and savory flavors being best perceived at the back.

The sense of **smell** consists in the perception of odors. This sense is located in the upper chamber of the nose, and is due to the filaments of the olfactory, the first cranial nerve, which form a network on the mucous membrane of that cavity (Fig. 56).

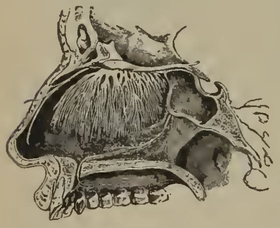

Fig. 56. — The nose divided down the middle line to show the distribution of the olfactory nerve. The roof of the mouth is seen below.

Odors are minute particles given off by the substances from which they emanate. And it is necessary for the action of the sense of smell that air, bearing the odor, should be breathed through the nose, when the particles come in contact with the mucous membrane where the sense is located.

The sense of **hearing** consists in the appreciation of sonorous or sound-producing vibrations. That these vibrations are better transmitted by solid bodies even the savage knows, when he puts his ear to the ground to hear the approaching footsteps of his enemy. In the same way sound can be transmitted to the auditory nerve through the bones of the head as well as through the orifice of the ear, as can be shown by taking a watch between the teeth and stopping the ears with the fingers.

It is rarely possible, however, for the ear to be connected with the source of sound vibrations by solids, and they are usually transmitted by the air and through the ear.

The **ear,** or organ of hearing, is composed of the pinna, the auditory meatus, the tympanic membrane, the middle ear, and the internal ear. The pinna is the external portion, the object of which is to collect the vibrations into the orifice of the auditory meatus. This portion is not of much importance in man, but in the rabbit or the donkey its importance is very great. The vibrations collected by the pinna then pass into the auditory meatus, which is a short tube closed at its inner end by a thin, strong membrane stretched tightly across it, the tympanic membrane. On the other side of the tympanic membrane is another cavity, the middle ear, closed at its inner end by bone, in which, however, are apertures also closed with membrane; through the middle ear and connecting the tympanic with the other membrane is a chain of very small bones called the ossicles of the ear. Beyond the middle ear is the internal ear, a cavity filled with fluid, in which reside the terminations of the auditory nerve, the cranial nerve which carries perception of sound to the brain. In order to reach the intelligence, then, the vibrations have to pass through the air, the tympanic membrane, the ossicles, the membrane of the internal ear, the fluid of the internal ear, and the auditory nerve.

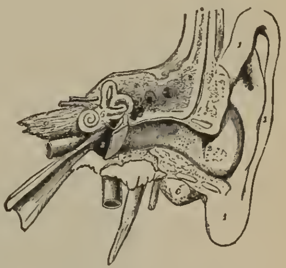

Fig. 57. — The ear, the temporal bone being divided to show the internal structures. 1, 1, 1. The pinna. 2. The auditory meatus. 2'. The membrana tympana. 3. The middle ear. 6. The internal ear, showing the cochlea and semicircular canals.

The sense of **sight** is the perception of form, size, color, light, or shade. It is the most important of the senses, and gives origin to the greatest number of perceptions. If a room be darkened, and light be admitted only through a small aperture, an image of the external objects opposite to the aperture may be seen on the wall where the rays of light strike. Were the rays of light further concentrated by a lens, the image would be still more distinct. The photographer's camera is but a reproduction of this room on a small

scale, and the eye is the original embodiment of both. It is a dark cavity, upon the posterior wall of which the filaments of the optic nerve are spread, so that when the light passes into the cavity through the pupil, an image of the objects opposite to it is formed on the posterior wall and transmitted by the optic nerve to the intelligence in the brain.

The eye is a ball surrounded by three coats, the internal of which — the retina — is an expansion of the optic nerve, and destined to receive the impressions of sight; the external in front is called the cornea, and is a transparent membrane; behind, it is a strong, whitish opaque membrane, called the sclerotic. The middle coat is incomplete in front, where it is called the iris, and the opening in the centre is called the pupil; the iris may be blue, gray, brown, or black, and from it the

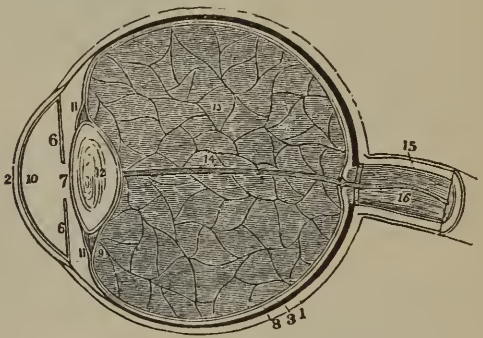

Fig. 58. — A section of the eye. 1. The sclerotic coat. 2. The cornea, connecting with the sclerotic coat by a bevelled edge. 3. The choroid coat. 6, 6. The iris. 7. The pupil. 8. The retina. 10, 11, 11. Chambers or cavities of the eye, containing the aqueous humor. 12. The crystalline lens. 13. The vitreous humor. 15. The optic nerve. 14, 16. Arteries of the eye.

eye derives its color; the middle coat behind is a dark-brown membrane, profusely supplied with blood-vessels, and called the choroid coat. Set in front of the eye, just back of the iris, is a lens, the crystalline lens, and before and behind the lens the cavities are filled with transparent matter called respectively the aqueous and vitreous humors. The eyeball is set into the orbit of the skull, and protected by the overarching brows and by the curtain-like eyelids, and the visible portion of the eyeball, except the cornea, is covered by the conjunctiva,

a membrane very abundantly supplied with blood-vessels and very subject to inflammation. The inflammation of the conjunctiva is the ordinary "sore eyes," and is technically known as conjunctivitis.

In using a burning-glass, it will be noticed that the glass has to be at a certain distance from the object to be burned in order to affect it. This is the distance at which the rays of light are concentrated by the lens, and is called its focus. Glasses of varying degrees of convexity have different foci. The crystalline lens of the eye has certain muscles which cause it to adapt itself to varying foci; this is the "power of accommodation." In some persons the lens is so altered that it cannot adapt itself to all circumstances. If the person can see better at distances, the lens is not convex enough, and the focus for near objects passes behind the retina; such a person is **hypermetropic** or "far-sighted," and needs convex glasses. If the person can see only at short distances, the lens is too convex, and the focus strikes in front of the retina, and the person is **myopic** or "near-sighted." Old people are often afflicted with far-sightedness, because, as age advances, the crystalline lens becomes harder and the muscles of accommodation cannot make it convex as before: this is called **presbyopia** or "old eyes." Sometimes the lens is not symmetrical, and the focus is not clearly thrown upon the retina: this is **astigmatism,** and a person affected with it would want a glass formed of a segment of a cylinder.

It not infrequently happens that the eye cannot distinguish colors. This is called "color-blindness." In some cases the power of discriminating between colors is entirely lost; in others the recognition of certain colors only is absent. A man may be green blind or red blind, for example. This defect is of vital importance, particularly in railway or steamship management, where signals are made by different colored flags or lights, as well as in many other avocations where the perception of colors is necessary.

Part II

THE IMPLEMENTS OF REPAIR

CHAPTER XII

GERMS, THEIR ACTION AND ITS CONTROL

When a ray of sunlight shines into a room, the sunbeam will be seen to be full of minute particles or motes floating in the air. These are not observed by the naked eye except under an extremely bright light, and from this we recognize the fact that the atmosphere is filled with floating particles. Some of these are large enough to be seen under a bright light, as we have remarked, but by far the larger number are invisible except with the aid of a microscope. The character and composition of these vary greatly. They may be merely floating bits of metal or of vegetable origin; they may be particles emanating from an animal; they may be decaying emanations from the breath; or they may be independent living organisms.

The discovery of the latter class, called *micro-organisms*, or microbes, has within a few years thrown a flood of light upon the practice of medicine and revolutionized the art of surgery. Many diseases are now acknowledged to be due to these micro-organisms. In consumption, for example, the tubercle bacillus — the micro-organism of consumption — finds its way into the system through the food or the breath, and wanders about until it finds a weak spot where circumstances are favorable for its growth. In the more common class of cases, this is found in the lungs, and here it establishes its home and increases and multiplies until the subject is carried off by the disease which it has planted in his system. The micro-organism of cholera and of some other diseases have been recognized.

There is another class of micro-organisms which require a break in the skin in order to exercise their power. These are the microbes which in former days rendered surgical opera-

tions so dangerous. An instance of the terrible power of some of them was of almost daily occurrence. How often has death resulted from the prick of a pen-knife or even the scratch of a pin! And in how many other cases has death been averted only by the amputation of a limb which has received some apparently insignificant wound.

Micro-organisms may be introduced into a wound either by the instrument making the wound, they may be floated to it in the air, or they may be derived from other substances coming in contact with it. Finding in a wound a suitable soil for its growth, the micro-organism multiplies with incredible rapidity, and by its presence produces processes of decay which result in the formation of poisonous substances called ptomaines. The products of the decay set up in a wound by micro-organisms are not only irritating to the wound itself, producing inflammation and pus, but when absorbed into the body cause disease of the entire system.

The agency of micro-organisms, then, in the production of disease, and the contamination of wounds being known, it becomes evident that the development of such troubles can be avoided (1) by preventing the entrance of micro-organisms, and (2) by their destruction in case they should be present. Upon these premises is founded the modern treatment of consumption, cholera, and other affections. The physician of the present day aims at the destruction of the infecting microbe in these cases by flooding the saliva in the first case and the excrement in the latter with a solution which shall have the power to annihilate the microbes. Such a solution is called a germicidal solution, and the agent giving it its power is a germicide or "germ-killer."

In surgical operations the surgeon avoids the action of micro-organisms in case of a fresh wound by preserving it from contact with any gas, fluid, or solid which might taint it. In other words, he keeps it scrupulously clean. In case of a wound which might have become infected, such as would be the case with any one received out of the limits of a properly equipped surgical operating-room, or with any instrument not previously purified, all possible infection should be avoided

by bathing it with a germicidal solution which would either kill the microbes, or an *antiseptic solution* which would paralyze and render them harmless. To prevent contagion from the atmosphere, surgeons frequently keep a germicidal solution constantly flowing over the parts during an entire operation.

When the time comes for a wound to be dressed, the future contact of micro-organisms is prevented by the application of a dressing that has itself been made antiseptic. Such dressings are prepared by filling a clean dressing with a germicide in a certain proportion. Cheese-cloth or tarlatan are the fabrics most frequently used for this purpose, and when so treated are called "antiseptic gauze." Where a bit of antiseptic gauze is available in case of a wound, it is a good plan to apply it at once in the absence of a medical man and retain it in place until removed by a surgeon.

In military life, such a dressing is made constantly available by the provision of the first-aid dressing-packet issued to soldiers. The essential portion of this packet, which is fully described in the chapter on dressings and applications, is an antiseptic compress which is designed to be applied immediately after the wound has been received.

It must not be inferred that the use of antiseptic agents as a protection against micro-organisms insures a good result in every case of injury, for such is not the case. Antiseptics merely greatly increase the probability of a happy issue, and their effect upon microbes may be counteracted by other causes.

As has been remarked, where absolute cleanliness in dressings and handling of the wound can be had in a fresh wound in a healthy person, antiseptics are not necessary. But this means *surgical cleanliness*, which does not mean the same as ordinary cleanliness, for the daintily white linen from my lady's linen closet may be a nest of unseen carriers of putrefaction. Surgical cleanliness signifies the absence of germ life.

However, where antiseptics are not available, ordinarily clean dressings and clean water may be used, since they are apt to be surgically clean also. A considerable proportion of

cases dressed in this way have done well, and good results may be hoped for in the future. But the simpler antiseptic agents are so common that occasions will be comparatively rare when one of them cannot be obtained.

Salt. — The ordinary table salt has antiseptic powers, as is shown by its prevention of putrefaction in salt pork and other meats. A tablespoonful in a pint of water will make an excellent solution.

Sugar also has antiseptic properties, and may be applied to the wound as a powder, or it may be made into a very thin syrup.

Vinegar, like salt, has shown its antiseptic powers by its action as a preservative. It may be applied to wounds in the proportion of one part to three or four of water.

Carbolic acid, a dangerous corrosive poison when taken internally, was the first antiseptic agent to be used in surgery. It should be in small transparent crystals, and used in the proportion of two teaspoonfuls to the pint of water.

Corrosive sublimate, when obtainable, is the most efficient germicide we have. It is, however, a most powerful poison, and must be greatly diluted when used. In the proportion of four grains to the pint of water, however, wounds may be bathed by it with perfect security. Corrosive sublimate does not dissolve rapidly in cold water, but a solution is quickly made by heating the water.

The destruction of germs by the disinfection of clothing, furniture, and houses, and its application to the prevention of the spread of disease, is again considered in the chapter on hygiene.

CHAPTER XIII

KNOTS AND BANDAGES

In the application, particularly of extemporized dressings, the knowledge of the proper method of tying a knot is of the greatest importance. If a bandage be fastened with an inse-

cure knot, it may slip and cause irreparable damage. Consequently the consideration of the subjects of knots should not be overlooked.

The False Knot or "Granny." — *This knot is described only for the purpose of showing what should not be used.* It is formed — the ends of the cord or handkerchief being held in the two hands — by winding the end held in the right

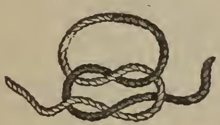

Fig. 59. — The false knot in cord.

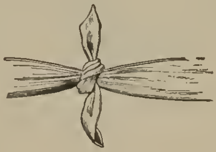

Fig. 60. — The false knot in handkerchief.

hand over that held in the left, and then, changing hands, winding that now held in the right hand over that held in the left. In other words, the "granny" knot is tied by simply repeating the same movements in making the second turn that were made in the first, and for that reason it is the knot most commonly tied by those who have not been instructed.

The Square or Reef Knot. — This knot is very secure when tied, so that it may be trusted to hold any kind of appliance in place. It is also very easy to untie, a matter of no little consequence in removing dressings. *This knot should always be employed.* It is formed — the ends of the cord or handkerchief being held in the two hands — by winding the end held

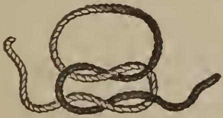

Fig. 61. — The reef knot in cord.

Fig. 62. — The reef knot in handkerchief.

in the right hand over that held in the left, — in this respect being exactly the same as the "granny"; then winding the end now held in the left hand over that held in the right. In

other words, the same end of the handkerchief is wound over the other in both instances, it having changed hands after the first turn.

Other knots which it is useful to know are the surgeon's knot and the clove hitch. The **surgeon's knot** is used by surgeons particularly in drawing tissue together, to prevent slipping of the first turn of the knot. It is tied simply by turning the right-hand end of the cord twice about the left in the first turn, and then completing the knot as in the ordinary reef knot. It should not be used in tying bandages.

Fig. 63. — The surgeon's knot.

The **clove hitch** is used when it is desired to get a firm hold of a limb in order to pull hard upon it, as in setting a dislocated joint. Its advantage over the ordinary loop is that it will not slip and bind the limb so as to stop the current of blood. Its construction can readily be understood from Fig. 64. The loops thus formed being slipped on to a limb, are drawn snugly but not so tightly as to constrict it, and then any amount of pulling on the two ends will not tighten it.

Fig. 64. — The clove hitch.

The triangular bandage presently to be described is always fastened either by the reef knot or by pins; and, in the latter case, the safety pin (Fig. 65), used by Esmarch himself, is much the more suitable.

Bandages are used to support various parts of the body when injured; to bind on and keep in place dressings for wounds and splints for broken bones; to overcome excessive muscular action; to prevent disturbance of parts by the patient himself; as temporary appliances to check bleeding; and for the protection of wounds from exposure to the elements, from insects, and from dirt.

Fig 65. — The safety pin.

Unbleached muslin, of a moderately heavy quality, is the material usually employed for bandages, although the bleached variety, linen, cheese-cloth, cambric, and other similar fabrics may be used with full as much satisfaction. Flannel is often used where warmth with elasticity is desired.

While bandages should be fitted snugly, care should be taken not to draw them so tightly as to constrict the limb. A tightly drawn bandage may readily cut off the blood supply of the parts beyond it, and cause gangrene or death of the part.

Bandages are chiefly of two shapes, the triangular and the ribbon-like, or roller bandage.

The triangular bandage, recommended by Mayor of Lausanne early in the present century, was introduced to popular use by Surgeon-General Esmarch of the Prussian service, who, in 1869, caused them to be furnished to the army under his supervision, with pictures printed upon them (Fig. 66) showing the principal methods of application.

Fig. 66. — Esmarch's triangular bandage.

Triangular bandages are made by dividing a piece of muslin a yard square into halves by a diagonal cut joining two opposite corners. This bandage is pre-eminently adapted for use on the battle-field and for any emergency.

These bandages, as issued under the direction of Esmarch, are like that shown in the cut, which is a photographic

reproduction of one issued by the medical department of the United States Army.[1]

The St. John Ambulance Association[2] of England, and the St. Andrew's Ambulance Association[3] of Scotland, each issue a pictorial triangular bandage. The Scotch bandage is really a remarkable affair, with no less than fifty illustrations, covering almost the entire field of first aid to the injured in a most clear and minute manner, and accompanied by a little book of instructions on its use.

In the illustration may be seen the creases made by folding the bandage. To fold it, the two ends are folded down to the point, and the square thus formed is folded in five.

The shape and size of the triangular bandage may be modified in various ways to adapt it to different purposes. If smaller triangles are desired, one, half the size of the large

Fig. 67. — Diagram, showing the points at which the triangular bandage is folded for use. *AB*, *CD*. Folds for broad cravat. *AB*, *wx*, *yz*. Folds for narrow cravat.

one, can be formed by folding the two ends together, and two may be made by cutting it along the line of the fold. Or it may be made into a cravat of varying width by folding

[1] Illustrated triangular bandages can be obtained in this country from any dealer in surgical instruments, either direct or through a druggist.

[2] These bandages can be had post free for sixpence each on application to the Honorable Director of Stores, St. John's Gate, Clerkenwell, London, E.C., England.

[3] The illustrated triangular bandage of the St. Andrew's Ambulance Association can be obtained post free for eight and one-half pence each, from the Secretary at the Head Office, 93 West Regent Street, Glasgow, Scotland.

it in lines parallel to the lower border. A *broad cravat* is made by folding the point down to the middle of the lower border, and then folding this again in the same way; the first fold would then be along the line *AB* (Fig. 67), and the second along the line *CD*. To form a *narrow cravat*, the first fold would be the same, *AB*, but there would be two secondary folds, *wx* and *yz*, instead of one. A *twisted cord*, formed by twisting the narrow cravat, may be used as an improvised tourniquet for checking bleeding.

The triangular bandage is of especial value because of the facility with which its uses can be learned and the rapidity with which it can be applied, while at the same time it makes as good a temporary dressing as may be desired. For this reason its use is first to be learned, and unless a high degree of proficiency is desired, a familiarity with its applications is a sufficient knowledge of bandaging.

The Triangular Bandage as a Sling. — There are three forms in which the triangular bandage may be utilized as a sling to support an injured arm.

1. *The Narrow Arm Sling* (Fig. 74) is made from either the broad or narrow cravat, as desired, and is applied by (1) placing one end over the shoulder of the injured side and (2) allowing the other end to hang down in front, while (3) the injured arm is bent up to the desired height in front of it; (4) the end hanging down is then drawn up in front of the arm and over the shoulder of the uninjured side; (5) the ends are drawn up over the shoulders so as to hold the arm in the most comfortable position and (6) tied with a reef knot behind the neck or over one shoulder.

2. *The Broad Arm Sling* is formed by folding the triangle but once — along the line *AB* (Fig. 67) — and applied in the same manner as the narrow arm sling.

3. *The Large Arm Sling* may be applied in three different ways, according to the extent and character of the injury.

a. (1) Placing one end (Fig. 68) of an unfolded triangular bandage over the uninjured shoulder, (2) let it hang down in front of the body with the point toward the injured side; (3) draw the point over well beyond the elbow of that

side, (4) raise the forearm to the desired level, and (5) lift the loose end of the bandage so as to support the arm in that position, and (6) pass it over the shoulder of the injured side, where (7) it is tied behind the neck or over the shoulder with a reef knot; (8) then the point is brought over in front and secured with a safety pin so as to form a rest for the elbow.

b. A second form (Fig. 69) of the large sling is formed by passing the loose end of the triangular bandage around under the arm of the injured side to the back, and tying the two ends there, the sling thus passing over the sound shoulder only. This variety is used where the shoulder of the injured side is so tender as not to be able to bear any weight.

Fig. 68. — Large arm sling, where the shoulder of the injured side is unhurt.

Fig. 69. — Large arm sling, where the shoulder of the injured side is hurt also.

Fig. 70. — Large arm sling, where it is desired not to place it over the shoulder of the sound side.

c. A third form (Fig. 70) of the large arm sling is the same as the second form, except that the sling passes over the shoulder of the injured side only, so that the sound arm can remain free for any purpose that may be required.

The Triangular Bandage for Wounds. — The mode of application varies according to the location and character of the injury, and each variety will be considered individually.

The Top of the Head. — If possible, the patient should be seated in a chair. Standing behind him, (1) fold the lower border of the bandage under, as if making a hem about two inches broad; (2) place the bandage (Fig. 71) with the

middle of the hem just over the nose, and the point of the bandage hanging over the back of the head to the neck; (3) bring the two ends back around the head above the ears; (4) cross them; (5) bring them around to the front again, and (6) tie them in a reef knot; then (7) pull the point downward to make it fit closely over the head, and (8) turn it up on to the top of the head (Fig. 73) and pin it there.

Fig. 71. — Triangular bandage applied to the head, from in front.

The Chin, Ears, or Side of the Face. — Using the narrow cravat, (1) place the middle under the chin, (2) draw the ends upward, and (3) tie them in a reef knot on top of the head.

The Eyes, or Front of the Face. — The narrow cravat is folded about the head, with the middle at the middle line of the face, and the ends tied behind in a reef knot.

The Neck. — The narrow or broad cravat may be used here, as circumstances may indicate, encircling the neck, and having the ends tied on the side opposite to the injury.

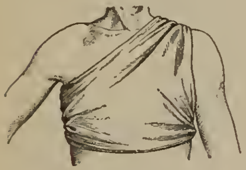

Fig. 72. — Triangular bandage for the chest, front view.

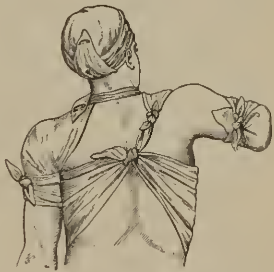

Fig. 73. — Triangular bandage for chest, — back view, — shoulder, hand, and amputation-stump of arm.

The Chest and Back. — (1) Apply the triangle (Figs. 72 and 73) with its centre at the middle of the chest and the point over the shoulder of the affected side; (2) carry the two ends about the body, and (3) tie them in a reef knot

at the back, (4) leaving one end considerably longer than the other; (5) then draw the point over the shoulder, and (6) tie it to the longer end left from the preceding knot. In case of injury to the back, reverse the procedure.

The Ribs. — In case of injury to the ribs, use two broad cravats. (1) Place the middle of the upper one over the site of injury, if it affect the upper ribs, and well up under the armpits; (2) pass it about the body, and (3) tie in a reef knot on the opposite side. (4) Place the other one similarly directly below the upper one, and apply it in the same manner.

The Shoulder. — (1) Lay the triangle (Figs. 73 and 74) on the shoulder so that the lower border will come down to the middle of the upper arm and the point will extend well up on the neck; (2) carry the two ends about the arm, (3) cross them on its inner face, and tie them in a reef knot on the outside; (4) make a narrow or broad arm sling, and (5) draw the point under the sling where it passes over the affected shoulder. In case the shoulder is injured so as not to be able to sustain the sling, a small cravat bandage passed about the neck may be used in its place.

Fig. 74. — Triangular bandage for shoulder, hand, and forearm, and as a narrow arm sling.

The Upper Arm. — Using the broad cravat, (1) place the middle of the bandage in front of the limb; (2) pass the ends about it, (3) crossing them behind, and (4) tie them in a reef knot in front (Fig. 74). Support the arm in a sling.

The Elbow. — Two plans may be adopted: *a.* (1) Place the middle of a narrow cravat on the back of the upper arm, near the elbow; (2) draw the ends to the front; (3) cross them; (4) pass them back, crossing them at the tip of the elbow; (5) cross them in front of the upper portion of the forearm, and (6) pass them around it, (7) tying the ends in a reef knot at the back.

b. Or pass a broad cravat about the elbow in the same manner as in the upper arm (Fig. 74).

The Forearm and Wrist. — Apply a broad cravat as in the upper arm (Fig. 74), and use a large arm sling.

The Hand. — There are two ways: *a*. Where it is desired to cover the whole hand (Fig. 74), (1) spread a triangle out, (2) lay the hand upon it with the wrist on the lower border and the fingers toward the point: (3) fold the point back over the fingers, carrying it above the wrist; (4) pass the ends about the wrist, binding down the point; (5) cross them; (6) bring them back, and (7) tie them in a reef knot over the point. This method may be used with advantage in dressing stumps after amputation, as has been done on the right arm of Fig. 73.

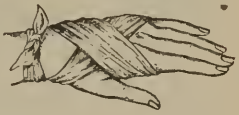

Fig. 75. — Triangular bandage, as a figure of eight, for the hand.

b. In case of an injury (Fig. 75) to the back of the hand, (1) place the middle of a narrow cravat across the back of the hand, just below the thumb; (2) bring the ends around the hand, crossing them on the palm; (3) bring the ends over the back, (4) crossing them over the back; (5) pass them back about the wrist, (6) cross them and (7) bring them back, (8) tying them in a reef knot on the back of the wrist. If the palm is wounded, the procedure is simply reversed. This is called a figure of eight handkerchief bandage for the hand, and the part should be supported in the large arm sling.

Fig. 76. — Triangular bandage for the hip.

The Hip. — (1) Pass a narrow cravat about the body like a belt, (2) tying it in a reef knot on the side opposite to the injury. (3) Lay a triangle upon the hip with its lower border well down on

the thigh, and the point upward. (4) Pass the ends about the thigh, (5) crossing them and (6) tying them in a reef knot, or pinning them on the outside; (7) slip the point under the belt, bring it over, and secure it with a pin (Fig. 76).

Fig. 77. — Triangular bandage for the knee.

The Thigh, Knee, and Leg. — The cravat is used (Fig. 77) in the same manner as in the upper arm.

The Foot. — (1) Spread a triangle out, and (2) place the foot in its centre, with the toes directed toward the point; (3) draw the point back over the toes and instep; (4) take the ends and pass them about the foot over the tip, (5) crossing them on the instep; (6) again in the sole of the foot, and (7) bringing them back, (8) tie them in a reef knot over the instep (Fig. 78).

Fig. 78. — Triangular bandage for the foot.

The Square Bandage. — A handkerchief a yard square makes a covering for the entire head and neck, excepting the face, and makes a very efficient protection. The handkerchief is so folded that the under layer projects about four inches beyond the upper. The long rectangle thus produced is laid upon the head so that its middle rests upon the middle line of the cranium, while the margin of the longer flap falls down to the tip of the nose, and that of the upper to the eyebrows, the short borders hanging upon the shoulders. Of the four corners hanging down upon the chest in front, the two outer ones are first tied firmly under the chin. The border of the under fold is then turned upward against

Fig. 79. — Large square handkerchief for the head. Preliminary stage.

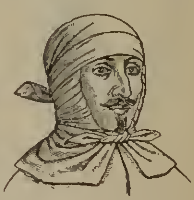

Fig. 80. — Large square handkerchief applied.

the forehead, and the two inner corners belonging to it are pulled forward from under the upper borders and carried to the back of the head, where they are tied in a reef knot.

The Four-tailed Cap. — A handkerchief three-quarters of a yard long and a quarter of a yard wide, and slit up for a considerable distance at the narrow ends, forms a most excellent covering for the head, and support for surgical dressings there. If it is desired to apply it to the top of the head, it is placed thereon, and the two front tails tied at the back of the head, and the back tails under the chin. If the back of the head is to be covered, the front corners are tied under the chin, and the two back ones over the forehead.

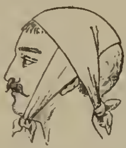

Fig. 81. — The four-tailed cap for the top of the head.

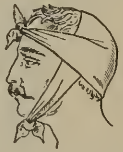

Fig. 82. — The four-tailed cap for the back of the head.

The Four-tailed Bandage. — A bandage three inches wide and thirty to seventy inches long, is slit from both its ends, leaving a space three inches long in the centre, producing four tails of equal length. A little slit is also made in the middle of the centre piece. If the bandage is short, the centre piece is applied to the chin, and the upper tails are carried behind the neck and tied in a reef knot, while the lower tails are similarly carried up and tied on the top of the head.

The Roller Bandage. — The roller bandage is a ribbon-like strip of varying material, prepared for binding about disabled parts of the body, and when not in use is rolled up into a cylinder.

The proper application of the roller bandage requires considerable practice and experience in order not only to apply it so as to appear smooth and even, but also to avoid unequal pressure, by some folds being drawn tighter than others, the entire bandage being drawn tight enough to prevent slipping, and loose enough not to strangle the part, from which great harm — extending even to the death and decay of the limb — may result. For this reason these bandages are better adapted to the trained hand of the physician and nurse. *The triangular bandage is better adapted to the non-professional hand,* and for that reason greater prominence has been given it in this work.

Roller bandages may be elastic, semi-elastic, or inelastic, according to the material composing them. India rubber is the chief constituent of the elastic bandages, which are used to check the flow of blood — when drawn tightly enough to cut off the circulation in a part, and, when so applied as to exert gentle pressure, are of value in the treatment of enlarged veins and the ulcers resulting from them. Semi-elastic bandages are made of flannel, silk net, or other materials possessing a certain amount of elasticity. They are easier to apply than the inelastic, for they can be simply rolled on without reversing.

Inelastic roller bandages, like triangular bandages, are usually made from a medium-weight unbleached muslin, although cheese cloth, bleached muslin, linen, cambric, and other similar fabrics may be used when necessary. Tarlatan and mosquito netting are used where the bandage is to be impregnated with a stiffening material.

The inelastic bandage is the most generally useful, and is far less expensive than the other varieties.

Bandages should not be cut, but torn, where the texture is of sufficient firmness to permit. And in any case the selvage should be torn from the edge, since it renders the margin less yielding than the remainder of the bandage, and is liable to produce unequal pressure.

The sizes most convenient for use vary both in width and length, according to the locality in which they are to be employed. The following table will indicate that of the more commonly used : —

Bandage	for the	Head, 2 to $2\frac{1}{2}$	inches	wide	and	5 to 7	yards	long.
"	"	Finger, $\frac{3}{4}$	"	"	"	1 to 2	"	"
"	"	Hand, 1 inch		"	"	4 to 5	"	"
"	"	Arm, $1\frac{1}{2}$ to $2\frac{1}{2}$	"	"	"	8 to 12	"	"
"	"	Shoulder, $2\frac{1}{2}$	"	"	"	8 to 12	"	"
"	"	Chest, 3 to 4	"	"	"	6 to 8	"	"
"	"	Leg, $2\frac{1}{2}$	"	"	"	10 to 12	"	"
"	"	Foot, $2\frac{1}{2}$	"	"	"	4	"	"

The roller bandage can only be conveniently applied after the strip has been rolled into a close, compact cylinder. The simplest and quickest way to form a strip into the cylinder is (1) to turn in one end of the bandage sufficiently to start a roll; (2) to place the bandage upon the thigh, with the partial roll near the groin, and the strip extending down on the thigh to the knee; (3) beginning with the tips of the fingers, roll the cylinder, already begun, between the hand and the thigh until the roll reaches the wrist; (4) draw the bandage up the thigh with the partly completed roll just below the groin, and repeat the manœuvre until the entire bandage is rolled.

A bandage may be rolled by turning the roll between the thumb at one end and the fingers at the other end, but the method is so slow as to be much less desirable than that given above.

Points to be observed in applying Roller Bandages in general: —

1. Begin at the lower end of a limb.

2. Avoid binding the limb too tightly or leaving the bandage too loose.

3. Leave the tips of the fingers or toes uncovered, so that they can be easily examined to see whether the bandage is too tight or not. If they are cold and blue, it should be loosened at once.

4. Apply the bandage smoothly, leaving no wrinkles.

5. Avoid unequal pressure, taking care that the turns of the bandage are applied with equal force, and that one edge is not tighter than the other.

6. Avoid reversing a bandage over a sharp bone; make reverses on the fleshy side of a limb.

7. Bandage a limb in the position in which it is to be retained; bandaging a limb straight, and then bending it, will bind it too tightly; and if a limb be bandaged, bent, and then straightened, the bandage will be too loose.

Fig. 83. — Rolling a roller bandage.

8. A bandage should not be applied wet, for it will shrink upon drying, and bind the limb too tightly.

The Roller Bandage Arm Sling. — (1) Raise the forearm to the height desired; (2) pass a three or four inch bandage about the forearm, just below the elbow; (3) then pass both ends around the neck; (4) bring the long end down under the wrist or hand, and (5) pass it up to the neck and tie it to the

Fig. 84. — Roller bandage arm sling.

short end. The arm is now swung in a double sling, being supported at the forearm and at the hand or wrist.

The Circular Turn. — In this turn the bandage passes directly about a limb, all the turns being upon the same level. A soldier's belt is a circular bandage of the abdomen.

Fig. 85. — The circular and rapid spiral turns.

The Spiral Turn. — In these turns the bandage is placed at an angle so that they encircle a limb in a spiral direction. There are two varieties of the spiral turn.

(*a*) The rapidly ascending spiral (Fig. 85) passes up the limb without its edges overlapping, and is used for holding dressings in place.

(*b*) The slowly ascending spiral (Fig. 86) passes up a limb, with the lower edge of each turn overlapping the upper edge of the preceding. This turn is applicable only where a limb is of uniform thickness, as often occurs in the upper arm.

Fig. 86. — The slow spiral turn.

The Reversing Spiral Turn. — This is a modification adapted to limbs which increase or diminish in size, and is designed to avoid the gaping of the turns which would occur with a simple spiral. Its application, clearly shown in Fig. 87, consists in simply turning the bandage over forward so that its upper margin will be below when the point of separation of two turns is reached, — repeating the manœuvre whenever necessary to prevent gaping.

The Figure of Eight Turn (Figs. 75 and 88). — This turn owes its name to the fact that it brings the bandage into the form of the numeral 8. In the hand it is formed (1) by placing

Fig. 87. — The three steps taken in applying the reversing spiral turn.

the end of the bandage at the palmar face of the wrist; (2) bringing it across the back of the hand and below the thumb, and (3) across the palm at the root of the fingers; then (4) up and across the back to the wrist; (5) across the palmar face of the wrist; then (6) up and across the back, over the first turn; (7) repeating these manœuvres as many times as it may be desired to fold the bandage about the hand, and (8) finally securing it with a circular turn about the wrist.

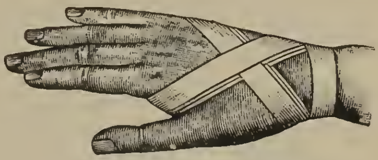

Fig. 88. — Figure-of-eight turn applied to the hand.

The figure-of-eight turn is employed especially where the bandage needs to pass over a joint.

The Spica Turn (Fig. 89). — This is a figure of eight with one loop very much larger than the other, and is employed at the junction of a limb with the body, as at the shoulder and the hip. Its mode of application is exactly similar to the figure of eight.

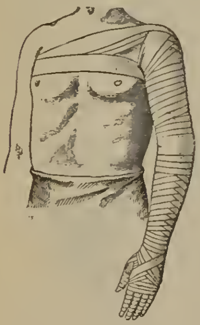

Fig. 89. — Roller bandage of the whole upper extremity.

To bandage the Whole Upper Extremity (Fig. 89). — To secure technical correctness, every digit and the entire hand should be bandaged with a narrow roller, as shown in Fig. 89. As a matter of fact this is rarely done, on account of the length of time required for it. The more common method is, (1) placing layers of cotton between the fingers and a larger mass in the palm; (2) to begin with the arm bandage at the tips of the fingers, and carry it up to the wrist by figure-of-eight turns, leaving the thumb out; (3) the forearm is then bandaged by a reversing spiral, (4) the elbow by a figure of eight, (5) the arm by an ascending spiral, and (6) the shoulder by a spica.

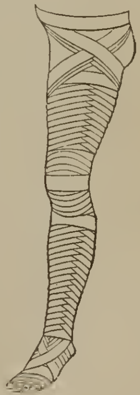

Fig. 90. — Roller bandage of the whole lower extremity.

To bandage the Whole Lower Extremity (Fig. 90). — (1) Catch the bandage by a turn or two about the toes, then (2) cover the foot by a narrow figure-of-eight turn; (3) bandage the leg with a reversing spiral, (4) the knee by a figure of eight, (5) the hip by a spica, (6) which is completed by a few circular turns about the belly.

The Double-headed Roller. — This is the roller bandage rolled from both ends to the middle. It is used for amputation stumps, and for drawing together the edges of wounds, but is especially employed for the head.

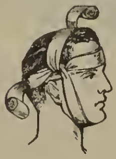

Fig. 91. — The knotted turn.

The Knotted Turn (Fig. 91), used especially to control bleeding from the temples, is formed by a double head, where turns — one perpendicular under the chin, and the other horizontal about the brow — are crossed at right angles upon the wound, and tightly drawn, as in tying up a parcel. A compress is thus held upon the wound under the knot.

The Capelline Turn (Fig. 92) is formed by a double-headed roller, one end of which passes around the head horizontally just above the ears, and fixes the turns of the other, which is carried alternately over the right and left side of the scalp, each turn overlapping the preceding one, so as to form a skull cap when complete.

There are a number of other special turns of the roller bandage used to protect and support various parts of the body, and of the head in particular, but it is believed that those enumerated here will suffice to meet any emergency.

Fig. 92. — The capelline turn.

To secure the Ends of Bandages. — Roller bandages are best secured with needle and thread: in default of that, with a safety pin; and in the absence of both, with an ordinary pin. Where neither pins nor needles are available, the end of the bandage should be split by a tear long enough to encircle the limb; tie the two ends at the end of the slit with the first motion of a knot, then pass them about the limb in opposite directions, drawing the bandage firmly, and tie them in a reef knot.

Bandages filled with Hardening Material are often applied where it is desired to render a limb immovable. These bandages are made of light, open-meshed material, such as gauze, tarlatan, crinoline, and mosquito netting. Plaster of Paris is the most common material used for filling these bandages; but starch and water-glass are also used for the purpose.

CHAPTER XIV

DRESSINGS AND APPLICATIONS

A DRESSING is a material applied to a wound both to protect it and to assist the healing process. It absorbs discharges and stands guard against dirt and micro-organisms seeking admission.

There are certain features of the dressings of wounds which are common to all varieties and which should consequently be considered before entering upon the discussion of individual injuries. Special dressings suited for particular injuries will be considered in connection with wounds, bleeding, and broken bones.

A wound having been prepared for dressing, it is customary to place upon it a mass of soft substance called a *compress*. Compresses may be made of various substances, the conditions demanded being that they are soft and unirritating, and are both generally and surgically clean — free from both dirt and germs. The materials most commonly used for this purpose by surgeons are cheese-cloth and tarlatan, and from these is prepared the modern surgical dressing, *antiseptic gauze*, made by impregnating these materials with a germicide. In this case, the fabric is folded into many layers, so that a sheet of the gauze has considerable thickness. Rolls of antiseptic gauze already prepared and put up in tin boxes, so as to avoid contact with the deteriorating action of the atmosphere, may be purchased in the apothecary shops, and should be present in every first-aid dressing-case. In using this material, the compress should be cut from the sheet, using the entire thickness.

Other materials useful for compresses are absorbent cotton, prepared from ordinary cotton by removing its oily constituents; absorbent cotton may be made antiseptic like gauze, and is often thus used in antiseptic surgery. Lint, prepared by scraping clean old linen, and charpie, prepared by ravelling

old linen and cutting up the resulting mass, have been very popular as wound dressings, although they are now practically disused. Oakum, formed by separating the strands of tarred rope, has been prominently in vogue, on account of the slight antiseptic quality imparted to it by the tar. It is rather harsh for a direct application to a wound, but the finer quality of oakum, called marine lint, is comparatively free from this objection. Linen worn soft and thin is an excellent wound dressing, provided that it is clean, both practically and surgically. Clean tissue paper makes an excellent application, and is often available in the form of toilet paper; it is much preferable as a dressing to handkerchiefs that have been used, and to bits of clothing that have been worn, for it is likely to be entirely free from germs. Clean printed paper crumpled into a mass and softened by clean water is not at all objectionable, and is vastly superior to soiled clothing. The iron in the ink rather adds to than detracts from its usefulness.

The shape and size of a compress varies according to the size, shape, and location of the wound it is to cover. It should never fail to be from a quarter of an inch to an inch in thickness — better too thick than too thin. It should overlap the wound in every direction by at least an inch, and, as before, it had better be too much than not enough. Surgical dressings are either wet or dry. Dry dressings are used where the direct application to the wound is a powder, but the wet dressings are much the more common and had better be used while awaiting a medical man. Where sugar, salt, vinegar, or, better, corrosive sublimate is present, antiseptic solutions, as described on page 90, can always be manufactured for wetting dressings, and should always be used. In the rare cases where none of these can be obtained, or where antiseptic gauze is available, clean water may be used.

Protective applications are used to cover and protect injured parts on one hand, and to protect the clothing from being soiled on the other. Sir Joseph Lister, the father of antiseptic surgery, was accustomed to apply a bit of gutta-percha tissue directly over his wounds to protect them from the irritating effects of his dressings. Where wet dressings are

used, it is well to cover them with oiled silk or oiled muslin. which not only avoids soiling the clothing, but also prevents the evaporation of moisture.

The First-Dressing Packet. — There are many occupations in which men are daily exposed to injuries. In times of peace, accidents are of frequent occurrence in large manufactories, sailors of the navy and more particularly in the merchant marine, workers in mines, railroad operatives, and many others are continually incurring considerable risk of injuries; in war times, perhaps, soldiers are in even greater danger; and, such is the perversity of inanimate things, accidents are most likely to occur when it is particularly difficult to obtain suitable dressing materials. This is

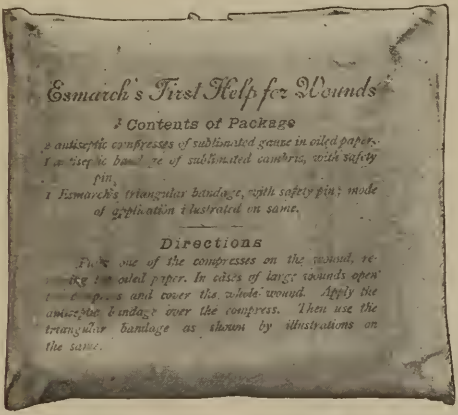

Fig. 93. — The first-dressing packet.

especially true in the military service, where, if an engagement be not fought in an inaccessible locality, the number of injuries is so great as to make it exceedingly difficult to provide proper dressings for all.

For this reason, an attempt has been made by the military authorities to guard against such emergencies by having

every soldier carry with him the dressing materials for his own possible injuries. This is the first-dressing packet, the one issued to the Hospital Corps of the U. S. Army, being a flat, flexible package (Fig. 93), about four inches square, and from three quarters to seven eighths of an inch thick, containing all the necessary materials for an emergency dressing, wrapped in a piece of gutta-percha cloth nine inches square. Upon the cover is printed a list of its contents and some brief directions for its use, viz.: —

Esmarch's First Help for Wounds

Contents of Package

2 antiseptic compresses of sublimated gauze in oiled paper.

1 antiseptic bandage of sublimated cambric, with safety pin.

1 Esmarch's triangular bandage, with safety pin; mode of application illustrated on same.

Directions

Place one of the compresses on the wound, removing the oiled paper. In cases of large wounds open the compress and cover the whole wound. Apply the antiseptic bandage over the compress. Then use the triangular bandage as shown by illustrations on the same.

The antiseptic compresses are cheese-cloth roller bandages, a yard long and three and a half inches wide, folded to two inches wide and three and a half long; the antiseptic bandage is a roller two yards long and four inches wide, and both are impregnated with corrosive sublimate, the most efficient germicide known to science. The oiled papers in which the compresses are wrapped serve to protect them from any external influences which may penetrate through the outer covering, and keep them from all possible contamination, and as well as the gutta-percha cloth cover itself can be used as a protective.

In case of a wound by a rifle ball passing through any part of the body, the two compresses should be applied, one at the entrance and one at the exit of the ball. In case of a

single large wound, the two may be combined, and by unfolding and refolding into another form they may be made to cover a wound ten or twelve inches long and three inches wide, or eight inches long and six inches wide. This would protect a shell wound of considerable size, while almost any sword cut that might be received could be dressed by it. The oiled papers should be bound over the compresses with the antiseptic bandage and secured with the safety pin. The whole wounded part may then be covered with the triangular bandage after the manner described in the chapter on knots and bandages, or that portion of the dressing may be used as a bandage to bind on a splint in case a bone has been injured, as a tourniquet to check bleeding in case of a wounded artery, or as a sling in case of an injury of an arm.

The first-dressing packet of the British army consists of two compresses of tow impregnated with wood tar to which ten per cent of carbolic acid has been added, each measuring dry four by five inches and one eighth of an inch in thickness; a carbolized gauze roller bandage four inches wide and two yards long, with a safety pin; and a triangular bandage without illustrations, folded and fastened together by four common pins. These are wrapped in a piece of tin foil seven and one half by ten inches, and then in parchment paper which is pasted together by sublimate paste; on the paper cover are printed also the directions for using the contents.

In the German and British armies, every soldier carries one of these packets in some specified portion of his clothing. The German carries it stitched, in some branches of the service, in his trousers, and in others, in his coat skirts; in the Soudan expedition the British carried them in their breast pockets. The place where the packet is carried is not of so much consequence as that it should always be the same, so that when required for use it can be found at once. The German plan of stitching it into the clothing so that it cannot be removed is an excellent one and prevents its loss.

The value of these packets has been conclusively demonstrated in actual warfare. At Tel-el-Kebir, after the Egyptians had been driven from their position, and the wounded of the British forces were still lying near their works, the dressings from the packets were applied in numerous instances with great benefit, either by the wounded men themselves, by their comrades, or by sanitary soldiers. In many cases it was done so satisfactorily that the surgeons found no further dressings necessary until the men were removed to the hospital.

The use of the packet as an immediate dressing insures for wounds a temporary treatment which will prevent the inroads of micro-organisms, and, as well, protect the parts from heat and cold, insects and dirt, until they can receive proper treatment. In this way are avoided erysipelas, gangrene, and other diseases resulting from neglect of the prompt treatment of wounds, while in many instances loss of limb, and even of life, is prevented.

Fixative applications are used both to hold the lips of wounds together and to retain dressings in place. The suture of silk or catgut with which a surgeon stitches a wound together is a fixative, and so is the bandage with which the dressings are bound upon the wound. Adhesive plaster is used for the latter purpose, but on account of the difficulty of keeping clean wounds that have been treated with it, it should never be applied to fresh wounds. They should rather be dressed with a compress and so retained until a surgeon can close them with sutures. The use of adhesive plaster in connection with wounds, then, is mainly confined to fixing dressings in place. Court plaster may be used for closing slight cuts of the skin resulting from ordinary household accidents. It is best, however, not to dampen the court plaster with the tongue, but with a little pure water, because the saliva is filled with micro-organisms, some of which may produce serious trouble in the wound.

Emollient applications are bland substances, either fatty or not, which, when applied to sore and inflamed surfaces, exert a soothing influence upon them. Such are the petroleum oils sold under the name of vaseline, cosmoline, petrolatum, and the like. Sweet, unsalted lard and butter, and oils of various kinds, are included under this head. They are also of use as applications to the surfaces about wounds, to prevent the dressings sticking. These ointments are often impregnated with antiseptics, so that they make an antiseptic application in themselves and, when covered with a suitable compress, make a very useful dressing. Carbolic acid is the antiseptic substance most commonly used for this purpose, and carbolized vaseline, cosmoline, and the like can be bought in the shops.

Poultices are emollients of sufficient importance to be considered by themselves. They are applied for the purpose of giving and maintaining in a part heat and moisture; they are soothing and allay pain; they assist the formation of matter in boils and abscesses; they draw the blood to the surface, relieving congestion of deep parts, and they absorb foul secretions and loosen sloughing matter from septic wounds. They are easily infected with micro-organisms, and should on that account, when used in connection with open sores or old wounds, be made antiseptic by the addition of some suitable germicide. Corrosive sublimate is not admissible here, but carbolic acid may be added in the proportion of a couple of teaspoonfuls to the pint of water, and powdered boracic acid and charcoal may be dusted over the face of the sore and over the surface of the poultice.

Any material which satisfies the requisite of retaining warmth and moisture may be used for a poultice. A compress of Iceland moss soaked for an instant in boiling water makes an excellent poultice. These compresses are sold in the shops as the "Poultice Instantaneous." Linseed meal is the material generally used by medical men, but other materials, such as bread crumbs, oatmeal, starch, corn meal, and bran may be used.

In order to prevent the escape of heat and moisture, a poultice should be covered in with oiled silk or muslin, or a layer of cotton wadding. They are very apt to stick unpleasantly to the parts after being worn for some time, and this may be prevented by covering the under surface with some thin material such as mosquito netting, or by smearing the part with oil or vaseline before applying the poultice. A poultice should be as hot as can be borne by the patient, remembering that children's skin is more sensitive than adults', and some adults' more than others'; testing it by laying it upon the back of the hand, or by holding it close to the cheek, is usually sufficient. Poultices cool after an hour or two and should be renewed at least as often as once in two hours to secure the best result. The poulticed part should never be left uncovered, but a new poultice should always be on hand to replace one when it is taken away.

Linseed-meal Poultices require for their manufacture (1) a small dish, (2) heat sufficient to boil water, (3) a table-knife, (4) a piece of muslin or flannel two or three inches larger each way than the desired poultice, (5) a piece of oiled silk or muslin of the same size, (6) a piece of thin cheese-cloth, tarlatan, or, better than either, mosquito netting, (7) sufficient linseed meal, and (8) boiling water. The poultice is then made by first scalding out the dish, then pouring in the boiling water — which should be kept boiling — and adding linseed meal little by little, stirring the mixture all the time, until it has the consistence of a thick paste. When the ingredients are thoroughly mixed, take a table-knife, and, previously dipping it into boiling water so that the poultice will not stick to it, spread the poultice about half an inch thick upon the muslin, which has been evenly laid upon the oiled silk; then lay the thin fabric over its face and neatly turn in the margins of the muslin and oiled silk to prevent the poultice spreading, and — first testing it to make sure that while as hot as it can be borne, it is not hot enough to be painful — apply it as needed.

Oatmeal and Corn-meal Poultices are made in the same manner as those of linseed meal.

Bread Poultices are made by boiling down some stale bread with water for five minutes, then draining off the water and spreading the bread on the muslin; then treating it the same as a linseed-meal poultice, except that its inner face should always be smeared with oil or vaseline before applying it. An objection to a bread poultice is its liability to become sour.

Starch Poultices are prepared by first making a stiff paste with cold water, then adding boiling water to give it the required degree of warmth. All the foregoing are spread and applied in the same manner as the linseed-meal poultice.

Bran Poultices are prepared by first making a flannel bag of the desired size, and then, after scalding the bran in a basin, putting it into the bag, the open end of which should be quickly sewed or pinned together; the bag with its contents should then be quickly wrung out in a towel and applied like a linseed-meal poultice.

Hot Moist Fomentations form another means of applying warmth and moisture to painful parts; they are more quickly

made than poultices and may be applied where quick action is desired. They form a useful application in sprains, and headache may often be relieved by laying them upon the brow, while the rapidity with which they may be made ready renders them peculiarly useful as an application to the belly in colic. The fomentations usually consist of flannel cloths wrung out in hot water. The best way to prepare them is to crumple the flannel into a wad and roll it up into the middle of a towel, then dip the middle of the towel with the flannel into hot water and wring it out well by twisting the ends of the towel in opposite directions, touching only the dry ends of the towel. The fomentation should be taken to the patient before it is removed from the towel, and, with precautions not to have it too hot, duly applied, the loss of heat and moisture being prevented by a covering of oiled silk or cotton wadding. They should be renewed as often as cooling shows it to be necessary. The action of the fomentations is said to be assisted by the addition of two or three tablespoonfuls of turpentine to the water.

Hot Dry Fomentations are applied whenever there is a lack of heat in the system, or in any part of it. The most common method of application is by means of hot-water bags of india rubber. However, in their absence, flannel bags filled with salt, bran, or sand, and thoroughly heated, may be used with great advantage. Where the heat is needed very quickly, ordinary bottles filled with hot water and tightly corked are an excellent substitute. Heated bricks, fragments of rock, flatirons, and many similar articles, when carefully wrapped in flannel or a bit of blanket, have been used for this purpose. The chill following great loss of blood, the coldness following an escape from drowning, the lack of warmth accompanying extreme prostration from many conditions, are all to be treated by dry fomentations. In these cases, the heated articles should be wrapped in cloths and laid in contact with the feet and along the side of the body, care being taken not to have them too hot, for in partially unconscious conditions the patient might be burned without having the power to move away.

Counter-irritants are commonly used as a relief to pain. They are useful in colic, muscular rheumatism, and other painful affections, and should be used as a rule under the direction of a physician.

The Mustard Plaster is perhaps the most common form in which counter-irritation is applied. The dry mustard should be mitigated by mixing with an amount of flour varying according to the effect desired, and stirred up with water, or preferably the white of an egg. This mixture is then spread upon a bit of flannel or muslin and laid upon the skin; if the skin be very sensitive, however, it may be desirable to lay a layer of some thin material over its face. The plaster should not be kept on too long, or it will form a blister instead of merely reddening the skin, as is desired. Fifteen minutes is usually long enough.

The Spice Plaster forms an agreeable and gentle counter-irritant, and is made by using a mixture of ordinary cooking spices with the white of an egg, in the same manner as a mustard plaster. This is particularly useful in children and persons with a very delicate skin.

The Mustard Poultice combines the good qualities of a poultice and a counter-irritant, and is a particularly excellent way to apply counter-irritation where deep-seated parts are to be affected. It is prepared by mixing mustard thoroughly with warm — not hot — water, making from a tablespoonful to half the bulk of the proposed poultice, according to the strength desired. Then, having made a linseed-meal poultice as already described, mix the mustard into it before spreading, and proceed as in a simple poultice.

Part III

EMERGENCIES AND ACCIDENTS

CHAPTER XV

HOW TO ACT AT FIRST

In the presence of an accident or other emergency, the first requisite is presence of mind. The slang expression, *keep cool*, is the first precept to be impressed upon the mind. Nothing is more fraught with danger to a person suffering from the depressing shock of a severe accident than the noise and excitement of an officious bystander; nothing, on the contrary, is more soothing and satisfying to such an one than a quiet, collected demeanor upon the part of those assisting him. A knowledge of the proper course to pursue in such cases will contribute largely toward investing one with the proper manner, but it is necessary, particularly for those of a more or less excitable temperament, to practise curbing the nerves, and to restrain themselves by the knowledge that a hasty act may precipitate most unhappy results.

But while excitement and haste are to be condemned, *promptness coupled with quiet* cannot be too earnestly sought. In many instances, the ready appreciation of the emergency, followed immediately by the application of the proper treatment, has been the means of saving a life to which a moment's delay would have been fatal. But rapidity must be distinguished from haste, and quick movements from excitement. The patient should never be able to read the danger of his condition from the countenance of his helper.

And while applying quietly and quickly whatever means of assistance he may be able to contribute, the helper must remember that his services are but temporary and only to tide over the time until educated assistance can be brought. Then, if it has not already been done, on coming into the presence of a medical or surgical emergency, *send for a doctor immediately!* The great danger of instruction in

methods of meeting emergencies is the tendency developed in some students to feel that they have mastered the healing art, and worse, to act in accordance with their feeling. The work of the layman instructed in first aid should be restricted strictly to the interval between his arrival and that of a qualified medical man. A step beyond this is a piece of presumption that might readily result in permanent damage, if not a fatal result to the patient.

The reason for the morbid curiosity which induces people to crowd about an injured person is difficult to discover. It may be a characteristic not eliminated in the evolution of man from the monkey. Even cattle and horses crowd about an injured one of their kind. It is not uncommon to see a person disabled on the street surrounded by a dense overarching wall of humanity, cutting off his supply of fresh air and polluting with the breath the small amount that he can obtain. The impropriety of this is evident; then *always keep crowds back and give the patient* AN ABUNDANCE *of fresh air*. On no account should a patient be annoyed by miscellaneous questioning, and certainly not by unnecessary handling or moving, which might, by reopening a wound or displacing a broken bone, cause serious injuries and even the death of the patient.

In many cases the course of action to be pursued in an emergency will be suggested by circumstances, especially to one who has made a study of the subject. Where no immediate action seems to be necessary, the patient should be placed in as comfortable a position as possible until the medical attendant summoned can arrive.

On finding a person who has been injured, particularly if he be unconscious, the individual himself and his surroundings should be observed with great care, since the case may come into the courts, where such evidence has been of vital importance. The location of the person with regard to surrounding objects should be observed, his relation to neighboring dwellings and the possibility of his having fallen from an elevated point, such as a window or roof. Any articles lying near by should be noted with a view to the possibility of their

having been used as missiles or weapons. A whiskey flask near by would suggest intoxication; a bottle labelled laudanum would create a suspicion of opium poisoning; a recently discharged pistol would cause a shot wound to be suspected, and a bloody knife would be suggestive of stabbing; while a riderless horse or a fallen ladder would make one think of injuries consecutive to a fall. The appearance of the ground surrounding should be examined to see whether it bears traces of having been trampled upon as in a scuffle or not.

The patient himself should be observed with great care — even his attitude may tell an important story. His clothing, if torn or cut, or soiled with blood, may be a valuable link in future evidence; and the location of his injuries, if there be any, should be noticed, as well as their relation to surrounding objects. All this should be taken in by a rapid survey immediately upon arriving upon the scene, and should not interfere with rendering the victim immediate assistance.

A sick or injured person should always be made to lie down on his back if the character of his injuries does not forbid, with his lower extremities extended and his arms by his side. If he seems faint, his head should be rather lower than his feet; if faintness is not present, the head may be raised a little and turned rather to one side. Nausea and vomiting are very apt to accompany emergency attacks, and the probability of this occurring should always be considered. If the patient be insensible, he should be watched carefully, and in case of nausea, turned to one side, so that the vomited matter can be thrown out of his mouth; if he is left upon his back, it will be likely to fall back into the windpipe and cause fatal choking. If he be conscious, he will the more easily be cared for.

All tight articles of clothing should be loosened to prevent interference with breathing or the circulation. Belts and collars in particular need attention.

The popular idea of relief to the injured seems to begin with the administration of stimulants. This is an incorrect and dangerous notion; for while there are but few cases in which stimulants are of benefit, there are many in which

they are injurious. Where there has been any bleeding, stimulants are liable to cause recurrence with all the dangers attendant upon it. In case of thirst, water is the best beverage — cold in summer and warm in winter. Warm water being distasteful to most persons, it may be administered in the form of tea or coffee or broth — they are vastly superior to alcoholic drinks. While there are a few conditions in which brandy or whiskey or wine may be given with advantage, they are comparatively so few, and subject to so many modifications, that such beverages should never be administered except under the direction of a physician.

In case of a person who is unconscious, or so weak as not to be able to give an account of himself, after meeting such indications as are conspicuous, he should be systematically examined. Beginning with the head, the fingers should be passed gently over it in the search for wounds, depressions, or bruises. If the eyes are closed, the upper eyelid should be raised to permit of examination, and the open eye should be examined as to whether the pupils are dilated or contracted, of the same size or unequal, and whether the eyeball is sensitive to the touch. Passing down the neck in the same manner, the two sides of the body should be carefully compared and any variation noted; the ribs and collar bones should be felt to see if they are sound. The breathing should be watched to see if it is easy or difficult, snoring or imperceptible, and the odor of the breath should be tested for indications of drugs or liquors taken. The arms and legs should then be looked over; the attitude, the increase or diminution of length of one as compared with the other, the possibility of bending at an abnormal point and crackling felt at the point, — all have their value and should be sought for.

If a wound be discovered in some part covered by the clothing, it should be examined to see whether it needs treatment or not, and if dressings are demanded, the part should be uncovered to a sufficient extent to permit their ready application. The examination should be made with the greatest gentleness on account of the extreme sensitiveness of injured

parts; and as little as possible of the person should be uncovered, for the natural tendency of an accident is to produce a greater or less amount of shock, which is manifested in a diminution of the heart's action with a cold feeling all over the body, often manifested by shaking chills and cold sweat. The chill, certainly, should not be increased by exposure of the body. The injured part should be exposed by ripping the nearest seam in the clothing and cutting the underclothing under it, taking care to uncover no more of the part than is absolutely necessary for the dressings.

When an injured person has been brought to his bed and has received proper attention, it will be desirable to remove his clothing. This should be done with the utmost gentleness, the sound side should be undressed first, and then the clothing removed from the injured side with as little disturbance as possible, assisting the process by ripping and cutting whenever the slightest difficulty appears. If it is necessary to replace the clothing upon an injured person, the injured side should be clothed first and then the sound side; but ordinarily no attempt should be made to put clothing on again — it is sufficient to lay it loosely about a patient.

Indications of Diseases. — Certain conditions or appearances point toward the existence of certain affections; these are signs or *symptoms*. A flushed face is a symptom of fever, of apoplexy, of epilepsy, and of intoxication, while a pale face indicates poor circulation or faintness. The eyes afford important symptoms: if the pupils are enlarged and the patient unconscious, paralysis, apoplexy, or belladonna poisoning are indicated; if they are very much contracted, on the contrary, opium poisoning and congestion, and inflammation of the brain are indicated; while if they are unequal, there is probably some brain trouble affecting but one side. Inability to move a limb or to feel sensations in a part indicate paralysis there; the same affection is indicated by a drawing of the face to one side and a dragging gait.

Bleeding from the mouth or nose occurs in a large number of disorders and cannot be said to be in itself a distinctive symptom; but when frothy blood is coughed in considerable

quantity from the mouth, bleeding from the lungs is to be suspected, and when the bleeding comes from the ears, nose, and mouth after a fall upon the head, fracture of the floor of the cranium has probably occurred.

Fits, spasms, or convulsions also occur in a variety of affections and may be very violent in epilepsy, drunkenness, and in insanity, kidney troubles, and apoplexy; comparatively slight causes, such as teething and even indigestion, will produce them in children, and on the other hand they may indicate extensive brain disease. The drunken man staggers in his gait, but disease of the brain or spine may also cause irregularity in walking.

A weak pulse is a sign of fainting, bleeding, shock, or collapse; an irregular pulse indicates heart disease; a slow pulse is a symptom of pressure on the brain and opium poisoning; and a rapid pulse leads to a suspicion of fever, although it may be due to nervous excitement, or may be the normal condition of the patient.

Difficult breathing may be due to a stoppage of the air passages, to broken ribs, to water in the chest, to disease of the heart or lungs, and to disease or injury of the breathing centre in the brain, or the nerves supplying the breathing apparatus. Snoring breathing, also called "stertorous," is a sign of pressure on the brain, as in apoplexy. Hiccup is a spasmodic breathing, and may be caused by indigestion, nervous trouble, and exhaustion. Coughing occurs in foreign body in the larynx, irritation in the windpipe or bronchial tubes, and in lung and heart disease.

Dizziness may be due to digestive disorders, kidney troubles, and brain affections, while shivering chills, aside from coldness, may point to the beginning of fevers, or to weakness and danger in the course of an illness.

It will be observed that it is rare that a single symptom points exclusively to a single disorder, and the physician relies upon a combination of signs for the identification. Typical cases of disease are rare, and two cases of the same affection may differ so greatly that the uneducated mind would never class them together.

Cases of feigning accidents or disease in order to profit by the sympathies of bystanders are not unknown. Indeed, men have been known to make an excellent living by simulating epileptic fits; in cases of fits, then, where the fall is very gentle and always at a point where a generous contribution is to be expected, and where the convulsions are never directed toward a body, contact with which might hurt the subject, such cases should be looked upon with suspicion. All the symptoms are probably assumed and the froth at the mouth produced by a bit of soap. Blindness and deafness are frequently feigned, and it has been a common practice among mendicants to irritate ulcers and other sores in order to obtain an excuse for soliciting charity.

CHAPTER XVI

BRUISES, BURNS, AND FREEZING

Bruises. — *Definition:* Wounds under the skin.

Causes: Blows, falls, squeezes, pinches.

Symptoms: Pain, at first numb, later sharper. Swelling. Change of color: at first a purplish red, fading out to a greenish brown, and lastly to a dirty yellow. In severe cases the symptoms of shock are present.

Treatment: If it be *slight*, cold applications, in the form of wet cloths and sponges; if more *severe*, cloths wrung out in hot water, and bran poultices; laudanum directly to the part relieves pain. *Very severe* and extensive bruises may involve deep tissues to a great extent, and treatment appropriate to each case must be administered by a physician. Shock, however, should be treated with hot, dry fomentations pending his arrival.

Bruises are technically known as *contusions*, and vulgarly as "black-and-blue spots," "black eyes," and by other names, varying according to the location.

The discoloration is caused by blood issuing usually from capillary blood-vessels, broken under the skin by the violence which has torn the surrounding tissues to a greater or less extent. Where the tissues under the skin are loose and spongy, a considerable amount of discoloration may occur. This is seen in the "black eye," where the amount of blood issuing into the tissues may be quite considerable. The discoloration does not appear at once, since it takes some little time for the blood to spread into the tissues sufficiently to be seen under the skin, but it is usually apparent in from a few minutes to several hours. However, if the parts especially bruised lie very deep, as when a bone is broken, it may take several days for the color to reach the skin. The blood soon begins to decompose to a suitable condition for absorption, and as the color fades out it is carried off and discharged from the system. The time required for the return to the normal color occupies a period varying — according to the extent of the injury — from a few days to several weeks, and even longer, in very severe cases.

While it would seem that without a break in the skin, an injury could not be very severe, as a matter of fact, the greatest amount of damage may be accomplished. The entire substance of a limb may be crushed to a pulp; large veins and arteries may be torn; the liver, kidneys, or spleen may be broken, and the stomach or bowels may be bursted, while the brain is peculiarly subject to such injuries, — without any external wound. In these severe cases the symptoms are correspondingly accentuated. Where the chest or abdomen has been bruised, injury to their contents is shown by spitting or vomiting blood, or passing it from the bladder or bowels. This is usually accompanied by great prostration, with feeble pulse, cold, clammy skin, anxious expression, and bewildered mind. The most important point of treatment in this case is to counteract the tendency to weakness by the application of warmth, inside and out. Hot, dry fomentations, consisting of bottles of hot water, hot flatirons, hot stove-lids — in fact, anything hot that can be obtained quickly, taking care to cover it, so as not to burn the patient's skin — should be applied at once. Hot drinks should be given him, coffee preferably, but in default of that any similar material. On account of their effect upon bleeding, alcoholic drinks should not be given. And, above all, *a surgeon should be instantly summoned!*

Where the accident affects larger vessels than the capillaries, the amount of blood lost into the tissues may be very large, and form a hæmatoma or "blood-tumor," and these require the care of a physician. If an artery is torn, the swelling forms very rapidly, and beats with the heart like the pulse of an artery.

In large bruises the parts may be so injured as to make it necessary to remove the bruised limb; and even in comparatively slight bruises the blood may break down into an abscess which has to be opened to let the matter out. Paralysis of a limb, necrosis or death of a part, and long-continued tenderness may result from an extensive bruise.

The treatment looks toward three points: (1) to stop the issue of blood; (2) to hasten the removal of blood already in the tissues; and (3) to diminish any resulting inflammation.

The first indication is fulfilled by the application of cold water or chopped ice to the bruise.

Both the first and second are fulfilled by stimulating washes; a mixture of three drachms of table salt and one drachm of muriate of ammonia in six ounces of baywater is perhaps the best of these; dilute alcohol and a mixture of dilute alcohol and water are also excellent applications for this purpose.

The second indication is also well fulfilled by kneading or rubbing the bruise with oil or a simple liniment, and by pressing a compress firmly upon it. The application of a mass of raw lean beef, so popular in the treatment of "black eyes," also belongs to this class.

The third indication is fulfilled by the cooling applications already mentioned. If an abscess should form, it should be treated by a surgeon.

Pain may be treated, in addition to the applications detailed, by the administration of anodynes, locally and internally, and always under the direction of a medical man.

Burns. — *Definition:* Injuries due to the action of too great heat on a part.

Causes: Contact with fire, very hot bodies or chemicals.

Varieties: Burns are divided into three classes, according to the degree of severity of the injury: (1) Mere painful redness. (2) The formation of blisters. (3) Charring.

They are also classified, in accordance with the material inflicting the injury, into (*a*) burns, produced by contact with fire, hot solids, or chemicals, and (*b*) scalds, caused by hot liquids.

Symptoms: Pain. Simple reddening of the skin in the first class, redness with the formation of blisters in the second class, and actual destruction of the skin and more or less of the underlying tissues in the third. In burns of the first two degrees, the skin only is involved, while in charring there is no limit. In severe burns there is apt to be a great amount of prostration with the symptoms which together form shock, described in the chapter on Fainting.

Treatment: Remove the clothing by cutting it away with a knife or scissors; if it sticks, do not pull it off, simply cut around it and flood it with oil.

Let the water out of blisters by pricking them with a new and absolutely clean needle or pin, and gently pressing them, taking great care not to break them and expose the tender surface underneath.

Promptly exclude the air by: —

a. In case of a slight burn of the first degree, and in particular of a scald, applying a compress wet with water in which is dissolved as much baking-soda as the water will take up.

b. In any case, applying any clean oil such as salad oil, olive oil, sweet oil, fresh lard, unsalted butter, vaseline, cosmoline, petrolatum. The white of an egg is even better than these, and all of them are improved by being carbolized by the addition of fifteen grains of carbolic acid to the ounce.

c. Better, however, by applying "carron oil," a mixture of equal parts of linseed oil and lime water.

d. In the absence of oils, by dusting flour or whiting over the burn. If nothing else can be gotten, moist earth, preferably clay, makes a useful application.

Cover the part with cotton or the nearest available substitute for it.

Burns caused by acids, such as oil of vitriol or sulphuric acid, carbolic acid, and the like, should first be thoroughly drenched with water and then washed with a solution of washing or baking soda and water; then treated like an ordinary burn.

Burns caused by alkalies, such as caustic potash, caustic soda, strong ammonia, and the like, should first be thoroughly drenched with water and then washed with vinegar or some other dilute acid; then treated like an ordinary burn.

Treat shock by hot, dry fomentations and warm drinks as prescribed in the chapter on Fainting.

In severe cases *send for a physician.*

Burns are by surgeons divided into six classes instead of three, as follows: (1) Simple redness of the skin. (2) Redness, with slight blistering, which leaves no mark after recovery except, perhaps, a slight stain. In these two classes the burn does not go below the epidermis or scarf skin. (3) Partial destruction of the true skin also, which leaves a scar, but no deformity. (4) Entire destruction of both scarf skin and true skin, which invariably leaves a scar, and always produces deformity, sometimes frightful in extent. (5) Destruction of muscles and other soft parts, followed by great deformity and possible loss of limb, if recovery takes place. (6) Charring of the entire thickness of a limb, which always imposes loss of the limb if the patient survives.

Burns are more frequently the result of carelessness than not. But they cannot always be avoided, as in accidents of various kinds, such as explosions of gas and gunpowder, explosions of lamps, falls upon stoves or into fireplaces, burning clothes, and the like. Scalds are caused by contact with steam, hot water, and other fluids.

The pain attending a burn is very intense, and the removal of clothing by cutting, instead of pulling it off in the usual way, is designed to avoid increasing it as well as to avoid tearing of the blistered skin and exposing the exquisitely tender surface below.

The chief indication in severe burns is to cover them as quickly as possible with something that will exclude the air. The application should be ready to apply the moment the clothing is removed. A very brief delay is likely to be fatal to the patient, from exposure of the burned surface to the air, especially in case of the chest and abdomen. For this reason it is well, where a burn is extensive, to expose and dress but a small portion of the burn at a time.

Baking-soda water — the bicarbonate, not washing soda or baking powder — and the oils are best applied by dipping into them, and the ointments like vaseline, by spreading them thickly upon, cloths, which are then immediately laid upon the burned or scalded surface. Both baking soda and carbolic acid have a soothing effect upon the pain. It is well to complete the dressing of a burn by covering the cloths with layers of cotton batting, cotton wadding, flannel, oakum, and other similar materials which should be bound lightly upon the part.

The inside of the mouth and throat may be scalded by drinking hot fluids or swallowing chemicals. In addition to the dangers attendant upon burns in other parts of the body, choking and smothering from swelling in the throat is to be feared in this case. Cloths cannot be applied here, and the oil or the white of an egg must be applied by drinking them. If the injury is due to chemicals, the mouth and throat should be rinsed by the proper antidote — vinegar or exceedingly dilute acid in case of caustic soda, potash, ammonia, or lye, and a solution of baking soda or washing soda in case of an acid.

It does no good to hold a burn to the heat, and the exposure may

often cause great injury to the system. Warm moist cloths are, however, very grateful in slight burns.

Where charring has occurred, more or less of the tissues have been killed, and the dead or "necrosed" portions will be cast off with the formation of matter. In these cases, the physician will take great care to use antiseptics to prevent infection of the wounds by micro-organisms. The process of casting off the dead matter may be hastened by the use of poultices, which must be antiseptic.

Fig. 94. — Deformity of the hand, due to a contracting scar after a burn.

Where the entire skin has been involved in a burn, the healing will form a troublesome scar which will ultimately contract and produce a deformity varying in degree according to the extent of the burn. The accompanying illustration shows a deformity of the hand due to a contracting scar after a burn. It is one of the milder cases; the deformities are often frightful in the extreme. To avoid this as much as possible, the parts should be placed in a natural position while healing and kept so.

Sunburn is caused by exposure to the rays of the sun, and is a burn of the first degree — simple redness of the skin; mustard causes a similar condition. The application of baking-soda water and of oils, unsalted lard and butter, white of egg and vaseline — plain, but preferably carbolized — is indicated here as in other burns of the same class.

Sunstroke and heatstroke, although they are accidents due to the action of heat, are considered to be best treated in the chapter on Fainting.

Burning Clothing, particularly that of females, has been the unnecessary cause of many horrible deaths, either from ignorance of the proper means of extinguishing the flames, or from lack of presence of mind to apply them. A person whose clothing is blazing should (1) immediately be made to lie down — be thrown down, if necessary. The tendency of flames is upward, and when the patient is lying down, they not only have less to feed upon, but the danger of their reaching the face, with the possibility of choking and of ultimate deformity, is greatly diminished. (2) The person should then quickly be wrapped up in a coat, shawl, rug, blanket or any similar article, preferably woollen, and never cotton, and the fire completely smothered by pressing and patting upon the burning points from the outside of the envelope.

The flames having been controlled in this way, when the wrap is removed, great care should be taken to have the slightest sign of a blaze immediately and completely stifled. This is best done by pinching it, but water may be used. Any burns and any prostration or shock should be treated in the manner prescribed for them.

It is always dangerous for a woman to attempt to smother the burning clothing of another, on account of the danger to her own clothing. If she attempts it, she should always carefully hold between them the rug in which she is about to wrap the sufferer.

Freezing. — *Definition:* An injury due to the action of too great cold on a part.

Causes: Exposure to excessive cold.

Varieties: (1) The *frost bite*, where portions only of the system have been affected. (2) General freezing, where the entire system is affected.

Symptoms: (1) Of the frost bite: Affecting projecting points on the person, such as the ears, nose, fingers, and feet, the affected part first tingles with pain and is red, and then blue or purple in color; as the freezing goes on, the part becomes white and free from pain.

(2) Of general freezing: The entire person, under exposure to severe cold, becomes chilled, stiffened, and pale; the mind becomes sluggish and drowsy; the extremities are benumbed and shrunken; unconsciousness supervenes, and unless proper restorative means are applied, death ensues without awakening.

Treatment: (1) Of frost bite: Too rapid warming is apt to cause mortification, hence the frozen part should be restored by rubbing with snow or with cold water until the white color is replaced by the natural hue and an aching pain is felt in the part — then treat like a burn.

(2) Of general freezing: In a dry, cool room which can be gradually heated, but not near a fire, the clothing should be removed and the body rubbed briskly and carefully, at first with snow or cold cloths, and then

with dry flannel; as soon as the ability to swallow is restored, stimulants and hot drinks should be given; upon restoration the patient should be snugly wrapped in warm clothing and put to bed; individual frost bites being treated as above.

Under ordinary circumstances, an hour's exposure to intense cold may determine a fatal result. This outcome, however, may be modified by circumstances: a covering of snow retains the heat of the body to such an extent as to considerably delay death; well authenticated cases are on record in which persons, buried even for days in the snow, have nevertheless survived and ultimately recovered with little permanent damage.

In a still day a very low temperature can be endured with comparative comfort, while a wind will make a much warmer day productive of great suffering. The rapid movement of the surrounding air carries away from the surface of the body the warmth which remains undisturbed on a quiet day.

When a part is frozen, it becomes bloodless, as is shown by the white color, and the object of treatment is to bring the blood back into the emptied tissues. There is danger, however, if the return of the circulation be produced too rapidly, that the resulting excess of blood in the part will produce mortification and decay, — gangrene and sloughing, — and for this reason, cold applications are combined with the rubbing, by which the circulation is restored.

The effect of cold is very similar to that of heat, and frost bites are much like burns, so much, indeed, that the after-treatment is the same. Like heat, cold produces blisters, which are treated by careful pricking with a new and absolutely clean needle or pin, pressing the fluid out, and dressing the frozen surface with oils or ointments.

Like charred burns, the dead matter resulting from the mortification of a frozen part should be treated antiseptically, and the process of throwing it off hastened by an antiseptic poultice.

Chilblains are the result of too rapid warming of cold feet. The blood having been to a considerable extent crowded out of the feet by the cold, when they are rapidly warmed, it finds its way back in so large a quantity that it cannot all be disposed of, and the excess can be seen collected in small patches, scattered over the sole of the foot — the chilblains. This form of congestion sometimes becomes chronic in persons of poor circulation. An individual subject to chilblains should never come in out of the cold and toast his feet at a warm fire. He should warm them by stamping or briskly rubbing them, and by warming other parts of the body. Astringent applications to his feet, such as alcohol or alum water, will usually control them when they have been developed.

CHAPTER XVII

WOUNDS

Wounds. — *Definition:* Injuries, in which an opening is made through the skin and more or less of the parts underneath.

Varieties: (1) Cut or incised wounds; (2) Torn or lacerated wounds; (3) Bruised or contused wounds; (4) Pierced or punctured wounds, including gunshot wounds; (5) Poisoned wounds.

Causes: (1) Of cut wounds, blows with sharp-edged instruments, such as knives, razors, and swords; (2) Of torn wounds, blows with blunt instruments, such as clubs or stones; irregular bodies, like fragments of shell and forcible tearing of a part from the body; (3) Of bruised wounds, blows with blunt instruments — torn wounds are usually bruised also; (4) Of pierced wounds, thrusts with narrow, sharp-pointed instruments, such as bayonets, arrows, and daggers — a gun or pistol shot also produces a punctured wound; (5) Of poisoned wounds, usually bites of venomous reptiles or insects.

Symptoms: Pain at the point of injury. An opening through the skin. Bleeding, varying in amount according to the injury. Where bones are broken, the signs of that injury.

Treatment: 1. If the wound be a large or disabling one, lay the patient in as comfortable a position as possible.

2. Stop the bleeding as far as practicable by the employment of the means described in the chapter on Bleeding, taking care not to destroy the clot, if one has formed.

3. Cleanse the wound from bits of glass, stone, splinters of wood, dirt, or any other matters of the kind, by washing with absolutely clean water, rendered

antiseptic if possible by a tablespoonful of common salt to the pint, or vinegar in the proportion of one fourth; or, better, carbolic acid or corrosive sublimate solutions, prepared as directed in the chapter on Germs. If clean water cannot be obtained, do not wash the wound; simply pick out the larger particles.

4. Place the edges of the wound as nearly as possible in their natural position.

5. Set any broken bones by the methods related in the chapter on Broken Bones.

6. Use a first-dressing packet in accordance with directions, if available; if not, apply compresses, prepared according to the methods detailed in the chapter on dressings, wetting them with the same antiseptic solution used for cleansing. Bandage this dressing neatly in place.

7. Apply splints, if necessary, not binding them directly upon the wound.

8. Apply a triangular bandage over the wound now dressed, and if it affect an upper extremity, support it in a suitable sling, as detailed in the chapter on Bandaging, and keep it quiet.

9. Treat shock by hot drinks, and hot, dry fomentations, as directed in the chapter on Fainting.

Through the appreciation of the germ theory, both the treatment of wounds and its results have, within a few years, undergone striking changes. The recognition of the fact that bad results and slow healing of wounds are due to the presence of poisons, developed by noxious germs, which have found their way into wounded tissues, has led to the observance, by surgeons, of the strictest precautions to prevent the entrance of germs, and to destroy or paralyze them if they should gain access to them. And by doing this, the surgeon of the present day is able to perform operations that would in former times have been considered as actual murder. With improved means of proceeding, hardly any part of the body is sacred from the surgeon's knife. We saw openings into the skull, and operate upon the brain; we open the belly and cut out kidneys, spleens, and parts of the stomach and bowels, the liver and pancreas, the bladder, and whatever other organs are contained in the abdomen; we open up joints and nail bones together, or cut out pieces of them; we cut off bits of the lungs, and even the heart itself is

likely to become subject to operation at no distant day, for it has already been pierced, and had blood pumped out of its cavity.

Several circumstances modify the danger of a wound, such as its depth, its extent, and its location. The character of the deeper parts affected also has a powerful influence upon the result: wounds of the blood-vessels are likely to result fatally, unless the bleeding is checked; wounds of the brain, lungs, and intestines are likely to be followed by death, unless treated with the utmost skill and care; heart wounds rarely fail to be mortal, while those affecting the bones and joints are liable to complications which may induce death.

The kind of wound inflicted also affects the result. Punctured wounds, such as stabs and shot-wounds, are the most dangerous in proportion to the amount of external injury inflicted, both because they may penetrate deep enough to sever a blood-vessel or injure other vital organs, and because foreign bodies, such as bits of clothing and splinters of bone, may have been carried into the wound in addition to the bullet, which is generally harmless to the surrounding tissues.

In a chapter devoted to the subject, methods of checking bleeding will be discussed in detail. It will be seen that bright red blood spouting in a jet from a wound indicates that an artery has been opened, and that such bleeding may be stopped by pressure upon a limb above the wound, or by thrusting a finger or thumb into the wound itself and holding it there until other means of arresting bleeding have been applied. If the bleeding consist of dark, blackish red blood pouring steadily from the wound, it will have originated in an injured vein, and this should be treated by pressing a thumb or finger into the wound until other more serviceable means of treatment can be applied. In either one of these cases a surgeon should be summoned immediately, especially if the amount of bleeding be great, and, meanwhile, no other dressings can well be applied except where bleeding has been checked by pressure above the wound, or by a plug in it: in this case a wet compress may be laid upon the wound pending the arrival of a surgeon. The wound, however, should still be watched with increasing vigilance, so that any recurrence of bleeding may be observed at once.

Slight bleeding, especially that from the capillaries, may be readily controlled by the application of a little hot or cold water, and by the pressure of dressings which may be applied at once.

Cleanliness is of Vital Importance to Wounds. All foreign matters should be removed. Dirt, bits of glass, gravel, or cloth, splinters of wood, fishhooks, pins or thorns, should be picked out and the wound washed with clean, or, preferably, clean water with germicides — corrosive sublimate, carbolic acid, salt, sugar, vinegar, etc. — in solution. Micro-organisms contained in water are killed by boiling, and fresh-boiled water may always be used with advantage where antiseptic solu-

tions cannot be obtained. In washing wounds, use absolutely clean materials, sponges, or masses of absorbent cotton or gauze if available, and failing these, use clean handkerchiefs or other linen, or paper. Do not use materials torn from the clothing of the patient or bystanders.

The wound should not be *mopped* with the sponge, and except in assisting in the removal of something especially difficult to extract, should not be allowed to be touched by it. The sponge should be dipped into the water and then held in the closed hand a few inches above the wound, with one corner protruding, and gently squeezed so as to cause a single stream to trickle gently down upon the injured surface. The force of the flow of the fluid used for washing should be varied according to the difficulty of washing away the dirt; the size of the stream can be increased by squeezing the sponge harder, and its force by holding it at a greater distance from the wound.

Fig. 95. — How to squeeze a sponge in washing a wound.

Unclean water should never be used — a wound had better be left dry. Stagnant water is particularly liable to be full of vegetable and animal microscopic life.

Any hair in the vicinity of a wound should, if possible, be carefully clipped short, and preferably shaven, to obviate any irritant action by its contact with the wound.

Having cleansed the wound, the injured parts should be carefully drawn as nearly as possible into their original position. This is of importance in diminishing the size of the scar. In a simple cut, if the edges are promptly drawn closely together, healing will occur without leaving any scar. The rapidity and completeness of the healing in such cases is often astonishing. Where a greater or less part of a finger or toe has been cut off with a sharp instrument like a knife or an axe, it has often been made to unite to the stump by binding it closely to the point whence it has been removed. In these cases, the amputated finger or toe has often readily grown again to its old place. *A finger or toe, then, which has been cut off should be immediately fitted into its place and neatly bound there in order to give it a chance to grow to the body again.*

The preferable method of retaining the edges of wounds together is by means of stitches of antiseptic materials; the surgeon uses silk, catgut, silkworm gut, and a number of similar materials. Horse hair properly treated may be used with advantage. Stitching, however, should not be attempted except by a medical man, or one who has had practical experience in the manœuvre under the eye of a surgeon. Stitching a wound leaves a much smaller scar than any other means of closing, and where a surgeon can be obtained, a wound should always be so treated.

Sticking-plaster will retain the edges of a wound together superficially, but it is impossible to keep an injury clean with plaster sticking to it, and where practicable to avoid it, the plaster should not be used. If, however, one is driven by necessity to use it, the wound should never be entirely covered by the plaster, since it would then confine any matter which might be secreted. The edges of the wound should be drawn closely together and held in place by narrow strips of plaster, leaving intervals between them for the escape of secretions and the contact of dressings. Where there is a marked tendency for the edges to gape, a larger sticking surface may be obtained by making the plaster a little larger at either end.

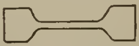

Fig. 96. — Mode of cutting strips of plaster to afford a larger sticking surface.

However, where adhesive plaster spread on muslin, such as surgeons use, is available, all contact of the plaster with the wound may be avoided by taking two strips of plaster one or two inches wide and a trifle longer than the wound. Lay these on either side of the wound with their inner

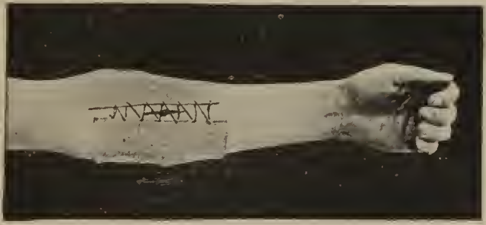

Fig. 97. — Wound closed by sticking plaster and laced threads.

edges a half an inch from it on either side, parallel to it and leaving about a quarter of an inch of the upper margin loose and having the remainder tightly stuck. Then with a needle and thread, preferably silk, draw the edges of the wound together by lacing the free edges of the plaster as shown in Fig. 97, fastening the thread at either end with

knots and pressing the plaster firmly down as soon as the thread has been drawn tight.

Any hair should be cut, by shaving, if possible, from localities where the plaster is to be applied. If the hair is left in place, the removal of the plaster sticking to it will be painful. Strips of sticking-plaster should not be drawn completely about a limb, on account of the danger of interference with the circulation of the blood in the extremity. In removing strips of plaster from a wound where it has been applied, the two ends should each be raised as in Fig. 98, and that part lying over the wound removed last.

Fig. 98. — Mode of removal of sticking-plaster strips.

Where stitching and closure with sticking-plaster are both impracticable, the parts should be drawn together as well as possible, and a compress applied and bandaged in place.

In dressing a wound, two objects are to be considered: (1) to retain the parts in a position suitable for healing, and (2) to prevent future dangerous complications. To fulfil the first, we apply stitches, adhesive plaster, compresses, splints, and bandages. The fulfilment of the second demands care against (*a*) catching cold, (*b*) getting into painful positions, or being jarred, and (*c*) the access of micro-organisms.

The parts having been cleansed and brought into proper position, the application of a compress is the next procedure in order. In the chapter on Dressings and Applications, the method of preparing compresses has been fully described. After a pad of antiseptic gauze, cloth, lint, oakum, cotton, paper, or other proper substance has been duly prepared, soaked with clean water, preferably boiled, or an antiseptic solution, it is gently placed upon the wound and made to lie closely upon it. As has already been noted, where absolutely clean water or antiseptic solutions cannot be obtained the dressings may be applied dry.

The compress is then bound securely in place by a triangular bandage, a folded handkerchief, or possibly a roller bandage, and the part placed in a comfortable attitude. The bandages may be left in place until the wound heals, or until the production of matter of a disagreeable odor shows that the dressings need renewing.

The injured part should lastly be placed in such a position as to give the patient the least discomfort, whether he remains on the spot or is carried away. If the head be so injured that the patient is unable to hold it up, he should be laid down with the head resting upon a pillow, extemporized, if necessary, from folded clothing, hay, straw, grass, or any other material which would answer the purpose, taking care that

the injury be kept from contact with the surrounding articles which might prove painful. If the arm be injured, it should be supported in a sling if the patient is able to walk; or supported in a comfortable attitude either across the body or by his side, if it be necessary to carry him. If a lower limb be affected, it may be supported by pillows, extemporized if necessary, in such a position as may be comfortable, while at the same time not tending to disturb the parts. If the chest be injured, the head and shoulders should be raised by pillows until the patient is able to breathe comfortably, the body being turned slightly to the injured side. If the belly be wounded, the patient should be made to lie down with his knees well drawn up and turned upon the injured side, or upon the back if the wound is in front.

Torn or lacerated wounds are almost always bruised as well, but are characterized by ragged edges. They may be caused by stones or bricks, clubs or broken glass, machinery, and many other agents. They may be dangerous in the extreme, especially in connection with accidents due to the railway, or machinery. An entire limb may be torn away, or it may be so crushed as to require to be amputated. In these accidents it often happens that the blood-vessels are so twisted as to close them, and render the bleeding comparatively trifling. Such injuries are to be treated temporarily like ordinary wounds — foreign matters are to be removed, the parts cleansed and covered with suitably prepared compresses, bandaged, and placed in as comfortable a position as possible. The pain in extensive injuries of this kind is often not very great, but the depression or shock is likely to be extreme; it should be treated with hot, dry fomentations, hot drinks, and the like, as detailed in the chapter on Fainting. Where the head, chest, or belly has been crushed, the accident is almost always immediately fatal; but in other localities, recovery occasionally occurs in apparently desperate cases. Small wounds of the head and face, because of the abundant blood supply, usually unite promptly, and with but a trifling scar, if the parts are neatly drawn together. Torn wounds generally, however, heal slowly, and by granulation, producing a greater or less amount of offensive matter, requiring frequent renewals of the dressings.

Pierced or punctured wounds are caused in war, by bayonets, swords, arrows, daggers, and similar implements; and in peace, by needles, thorns, splinters, fish-hooks, bits of glass, and other articles of like character. The immediate treatment of pierced wounds in general, after the piercing body has been removed, consists simply in the application of suitable wet compresses. If the wound be large, the injury of important organs of bleeding may modify the treatment. Upon removing a *needle*, examine it, to see if any of it has been broken off in the flesh. If any portion has been left behind, or if the whole needle has been pushed in, do not try to remove it, but keep the part absolutely still, and summon a surgeon. Any movement of the part will cause

muscular contractions, which may so move the needle in the flesh that it cannot be found when the surgeon comes to look for it. *Thorns* should be pulled out, and, if poisonous, the wound should be treated like a poisoned wound.

Splinters should be pulled out by slipping the point of a pen-knife under the protruding end of the splinter, catching it against the blade with the thumb nail, and drawing it out. If the end does not protrude, the scarf skin over it can be pricked away with the point of the knife,

Fig. 99. — How to pull out a splinter.

until the end of the splinter is uncovered, when it can be removed as before. If a *splinter be located under a nail*, and the end be broken off so that it cannot be reached, the nail over the splinter should be scraped thin to the tip on the outside; a little tongue can then be gently cut out over the end of the splinter, which may then be raised on the point of the knife, and drawn out as in other parts. When the splinter cannot all be removed in this way, the cutting away of the nail will make it easier for the remainder to work its way to the surface after the formation of matter. *A splinter in the eye* may be drawn out, as in other parts, if it can be reached. If it cannot be reached, the eye should be covered with a cold, wet compress, and so kept until the arrival of a medical man. On no account should a non-medical person attempt to interfere with splinters buried in the eye.

In the case of needles or large splinters, where a portion may possibly remain in the flesh, the part which has been pulled out should be kept to show to the medical adviser when he shall have arrived, in order to assist him to determine the character of the portion left behind.

Fish-hooks and arrows in the tissues demand much the same treatment, the difficulty in removing both being due to the barbed point. As fish-hooks never penetrate deeply, they can readily be pushed through the tissues — they should never be drawn back unless the barbed point has been cut off. The best method of treating fish-hooks in the flesh is to draw them through: this procedure is assisted by cutting off the loop by which they are connected to the lines. So with arrows — where the tip lies near the surface, and important organs are not in the way, — they may be pushed through. Where this is impossible, a string should be firmly tied about the shaft, so that it cannot slip, within a half an inch of the wound, and the shaft should then be cut off a half an inch above that point. The wound should then be treated with antiseptic compresses, until a surgeon can remove the arrow. The string will prevent the arrow's being lost, should an accidental movement push it into the tissues.

Gunshot wounds, including pistol-shot wounds, are pierced and often torn wounds. Like other wounds, they should be treated by checking bleeding, removing superficial dirt, applying antiseptic compresses, and, lastly, splints to prevent unnecessary movements. Often the bleeding from these wounds is very slight, and is checked by the simple pressure of the dressings. There is apt to be much depression and other symptoms of shock, which should be treated by hot drinks, and hot dry fomentations, as directed in the chapter on Fainting. The bullet is apt to be the source of much anxiety to the uninitiated. Ordinarily, there is no danger whatever in the presence of a bullet in the tissues. It is the wound made by the bullet that bothers us. There are thousands of men walking about the country to-day with bullets in their bodies, which are not of the least trouble to them. A shot wound, then, should be treated like an ordinary wound, and without regard to the presence of the bullet.

Wounds of the chest may penetrate into its cavity or not. If they do not, their treatment is the same as that of simple wounds in other parts. If they do penetrate, they are liable to involve the organs contained within it. If the heart is wounded, death usually quickly follows; although that this is not always so is shown by a considerable number of cases recorded in surgical literature. If the lung be wounded, difficulty of breathing, coughing, and spitting of blood will occur, and the lung may protrude through the wound. Such an injury should be treated by making the patient lie down upon the wounded side, so as to let the blood drain to that side, and keep absolutely quiet: an attempt should be made to check excessive bleeding, and the wound should be dressed with a compress, and the entire chest closely surrounded with bandages. Penetrating wounds, in rare instances, do not involve the organs in the chest.

Wounds of the abdomen, like those of the chest, may penetrate into

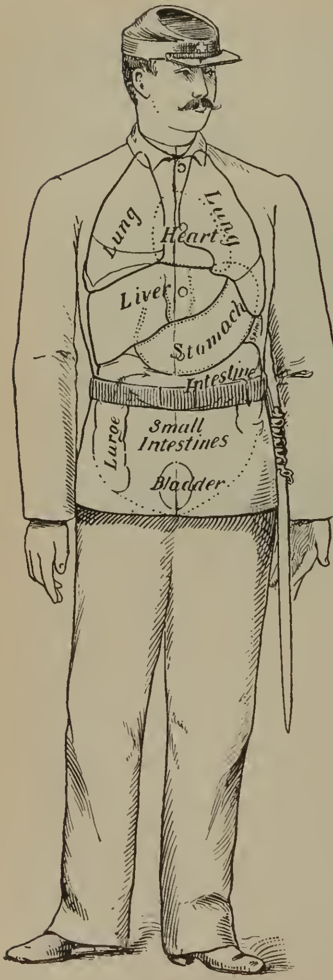

Fig. 100. — Relations of the organs of the chest and abdomen to the clothing.

the cavity or not. If they do not, their treatment is the same as that of simple wounds in other parts. If they do penetrate, they may involve the organs of the belly or not. The bowels or other parts may protrude from the wounds, and may or may not be injured. If the bowels or other parts protrude, they should be carefully examined, — the hands having previously been washed either with an antiseptic solution or with clean water, — and if they are uninjured, gently pushed back into the belly. If they have been injured, they should *not* be returned, but should be covered with wet fomentations as hot as can be comfortably endured with the hand. These in turn should be thoroughly covered to prevent cooling. And a surgeon should have been summoned.

All wounds of the body are likely to produce great shock, and every effort should be made to sustain the victim by hot drinks and other treatment appropriate to this condition.

Penetrating wounds affect different organs according to their location. In Fig. 100 an effort has been made to show the relations of these organs to the uniform of the soldier, and from it a similar notion of the relations of the clothing of others may be derived.

In the chapter on Bones, the method of identifying the different vertebræ of the spine has been related. The verte-

bræ bear constant relations to the organs of the chest and belly, and by an examination of them an idea of the parts probably injured in a wound of the body may be obtained. It is easy to discover the spinal processes of the vertebræ by briskly rubbing the hand up and down along the back of the spine, when each one will be marked by a red spot. The following table, from Holden's Landmarks, indicates the relations: —

Cervical Vertebræ.	5th.	Beginning of the œsophagus or "gullet."
	7th.	Upper extremity of the lungs.
Dorsal Vertebræ.	3d.	(*a*) Apex of the arch of the aorta, the great fundamental blood-vessel of the body. (*b*) Division of the trachea or "windpipe" into two primary bronchial tubes.
	4th.	(*a*) Upper margin of the heart. (*b*) The beginning of the arch of the aorta on the right side, and (*c*) its end on the left side.
	8th.	Apex or lowest point of the heart on the left.
	9th.	(*a*) Passage of the œsophagus or "gullet," through the diaphragm or "midriff" into the abdomen or "belly." (*b*) Upper edge of the spleen on the left.
	10th.	(*a*) Lower edges of lungs. (*b*) Upper orifice of stomach on the left.
	11th.	Lower edge of spleen on the left.
	12th.	(*a*) Lowest part of the cavity of the chest (*b*) Passage of the aorta through the diaphragm.
Lumbar Vertebræ.	1st.	(*a*) Arteries of the kidneys, and (*b*) the centres of the kidneys themselves on both sides.
	2d.	(*a*) End of spinal cord. (*b*) Pancreas or "belly sweetbread."
	3d.	Umbilicus or "navel."
	4th.	(*a*) Division of the aorta. (*b*) Highest part of the hip bones on both sides.

The dangers of wounds, when not properly treated, are many. Blood poisoning, gangrene, or death of a part, excessive production of matter, together with great depression due to it, long-continued inflammation, and high fever are liable to follow any wound, and are due to the fact that micro-organisms have gained access to the wound. Even the smallest wounds may be productive of the most unfortunate consequences, when neglected. Small scratches and pricks, when not properly cared for, may result in inflammations a d formations of gatherings or abscesses, which may disable a person for a considerable time, or cause loss of a limb, or even of life itself. This fact still further emphasizes the necessity for the utmost care in removing all impurities from a wound at once by washing

with clean water at least, and covering the wound with a bandage of some kind to protect it from contact with possibly injurious matter.

The process of healing of wounds varies according to the nature of the injury and the character of the treatment. The processes may be grouped into two general classes, (1) Primary union or "first intention," and (2) Secondary union or "second intention."

1. Primary union occurs rapidly and without the formation of matter, and leaves only a slight scar. It can be obtained in wounds with clean-cut edges, where the margins can be perfectly fitted together without anything intervening; they must be kept perfectly quiet and protected from outward injury and from contact with external impurities. In this case, a material called lymph, which is practically the liquor sanguinis, is thrown out from the capillaries in the wound and acts like glue in sticking the sides of the wound together. The capillary vessels are then extended across the wound, and the circulation through it becomes as complete as before the injury. The surgeon always seeks to approach as near primary union as possible, a wound uniting by this process completely in two or three days. Under old methods such a result was comparatively uncommon, but with the recognition of the functions of micro-organisms and the means of preventing their action, the surgeon is able to obtain primary union in the great majority of cases.

2. Secondary union, second intention, or granulation, occurs slowly with the formation of matter and leaves a considerable scar. In this case (*a*) more or less of the tissues may have been lost, as in deep burns, ulcers, or wounds where more or less of the tissues have been torn out; (*b*) the tissues adjoining the wound may be so injured as to be incapable of new life, as in cases where the parts have been bruised or torn to a greater or less extent; (*c*) foreign matters, such as bits of cloth, or even clots of blood, may be interposed between the edges of the wound; (*d*) the wound may not have been kept quiet; (*e*) micro-organisms and dirt may have been allowed to enter the wound, causing decay of the tissues and the formation of matter.

In these cases there is a vacancy which has to be filled up by new tissue. This is accompanied by the development in the wound of small red bodies like pin heads, called *granulations*, which are often covered to a greater or less extent with a thick, creamy fluid consisting of lymph with white blood corpuscles which have escaped from the capillary vessels. These granulations increase in number until the cavity of the wound is entirely filled. When this occurs, the skin at the edges of the wound begins to grow inward toward the centre, gradually diminishing the size of the opening until it is entirely covered by a fine red skin called scar tissue; as time passes, the unnecessary blood-vessels which at first are very numerous disappear and the scar loses its red tinge, often becoming whiter than the surrounding skin; at the same time the scar

becomes harder and contracts, so that if it be a large one the parts may be greatly drawn, as seen in the hand illustrated on page 130. While this is going on at the surface, the capillary blood-vessels find their way among the granulations, and the mass is organized into new tissue. Healing by second intention requires from a week to several months for its completion, according to the size of the wound and the favorable character of its surroundings.

The excessive formation of granulations causing them to project above the surrounding skin is commonly known as "proud flesh." And where a wound refuses to heal, but breaks down with the formation of granulations and the production of yellow or greenish yellow matter or pus, it is commonly said that the wound has "festered."

The healing of wounds is modified by many conditions. A wound is apt to heal more rapidly in a healthy than in a delicate person. Youth is a great advantage, and habitual drinking a great disadvantage. A wound of the head heals, as a rule, more rapidly than one in any other part of the body, while one of the upper extremities closes more quickly than one of the lower.

Poisoned wounds naturally heal badly, but these are reserved until they can be considered in the light of an acquaintance with the action and effects of poisons in the chapter devoted to that subject.

CHAPTER XVIII

BLEEDING

Bleeding. — *Definition:* The escape of blood from its vessels.

Varieties: (1) Arterial bleeding — the most dangerous. (2) Venous bleeding. (3) Capillary bleeding or oozing — the least dangerous.

Causes: (1) Of arterial bleeding: a wound of an artery. (2) Of venous bleeding: a wound of a vein. (3) Of capillary bleeding or oozing: a wound involving only capillary vessels.

Symptoms. *A.* Common to all: The appearance of blood, except in internal bleeding. Where severe and not promptly checked, the face is first pale and

then blue, the pulse sinks, the body becomes cold, the patient is dizzy and inclined to vomit, the eyes are dazzled, he hears noises, and finally becomes unconscious.

B. PECULIAR TO EACH VARIETY. (1) Of arterial bleeding: color bright red, and spurts in jets. (2) Of venous bleeding: color dark red or purplish, and wells out in a continuous stream. (3) Of capillary bleeding: slow oozing of blood, neither dark nor bright red.

Treatment: 1. Of *arterial* bleeding. SUMMON A SURGEON IMMEDIATELY! (*a*) Expose the wound. (*b*) Make the patient lie down, and lift up the wounded part. (*c*) Press with the thumb or finger on or into the wound to temporarily stop the bleeding. (*d*) If the location of the large artery of the part is known (as per appended table), press upon it above the wound with the fingers, and later with a tourniquet; if the location of the large artery is not known, surround the limb above the wound with a bandage drawn so tightly as to check the flow of blood. (*e*) Dress the wound with a compress and bandage.

POINT WOUNDED.	ARTERY TO COMPRESS.	LOCATION.	PART PRESSED AGAINST.
Arm (see also Forearm)	Subclavian.	Runs over 1st rib, back of middle of collar bone.	First rib.
	Axillary.	Runs along the arm side of the armpit, near the front of the arm.	Arm bone (Humerus).
	Brachial.	Runs along inner border of the biceps muscle.	Arm bone (Humerus).
Armpit.	Subclavian.	Runs over 1st rib, back of middle of collar bone.	First rib.
Cheek.	Facial.	Runs over lower jaw bone one inch in front of its angle.	Lower jaw bone.

Point Wounded.	Artery to Compress.	Location.	Part pressed against.
Chest.	Intercostal.	Runs along inner margin of upper or lower border of rib.	Inner face of adjacent rib.
Face { Lower part	Facial.	Runs over lower jaw hone one inch in front of its angle.	Lower jaw bone.
Face { Upper part	Temporal.	Runs along temporal bone just in front of the ear.	Temporal bone.
Finger . . .	Digital.	Front of finger on either side.	Phalanges.
Finger . . .	Palmar arches.	Palm of hand.	Metacarpus.
Foot { Sole . .	Posterior tibial.	Runs about and below the external malleolus.	Tarsus.
Foot { Top . .	Anterior tibial.	Runs down middle of front of ankle.	Instep (Tarsus).
Forearm.	Brachial.	Middle of elbow and inner side of biceps.	Arm bone (Humerus).
Hand.	Brachial.	Middle of elbow and inner side of biceps.	Arm bone (Humerus).
Knee.	Femoral.	Middle of upper part of thigh.	Hip bone.
Leg (see also knee and thigh).	Popliteal.	Middle of back of knee.	Thigh bone (Femur).
Neck.	Carotid.	Front margin of sterno-mastoid muscle from back of ear to sternum.	Spine.
Thigh.	Femoral.	Middle of groin.	Hip bone.

2. Of *venous* bleeding. Summon a surgeon immediately! (*a*) Expose the wound. (*b*) Make the patient lie down, and lift up the wounded part. (*c*) Loosen any tight clothing between the wound

and the heart. (*d*) Press with thumb or finger on or into the wound to temporarily check the bleeding. (*e*) Prepare a thick compress and, removing the thumb or finger, bandage it firmly upon the wound.

3. Of *capillary* bleeding. Apply water as hot as can be endured, or apply ice-cold water to the wound; or simply bind a compress firmly upon the part.

In no class of injuries is the prompt application of ample means of relief of so great value as in bleeding or hemorrhage. At least one-fifth of the deaths upon the battle-field in former days were due to bleeding, which might have been controlled by the prompt application of means with which every person might readily have been familiar. And in no class of cases is the aid applied more clearly a makeshift until the proper relief can be given by a surgeon. This is especially true of arterial bleeding, for the means already stated will permanently relieve capillary bleeding, and in the majority of cases venous bleeding will require no further treatment.

The chief agent in permanently controlling hemorrhage is the clotting of the blood. It has been shown that when the movement of blood through the blood-vessels ceases, the fibrin appears in a network which entangles the corpuscles in its meshes and produces a red elastic mass, a blood-clot. When there is an obstruction within a vessel, the current of the blood is interfered with, and a clot forms behind the obstruction.

Where the force of the blood in a vessel is not very great, a clot formed may be a sufficient stay to the flow of blood. This force is called the blood pressure. In veins, it is only a quarter of a pound to the square inch. Consequently, when a flaccid vein is compressed together, and a clot firmly forms at the point of pressure, there is not force enough to drive this plug of clotted blood out of the vein and start the bleeding again. For this reason, simple pressure for a short time upon a bleeding vein is often sufficient of itself to check such bleeding. In the capillaries, the blood pressure is lighter still, so that clots form with great rapidity and promptly close these vessels when wounded.

The blood pressure in the arteries, however, is from ten to sixteen times that in the veins, or four pounds to the square inch. Consequently, except in very small arteries, where the force has become greatly diminished, a clot formed during pressure will be promptly forced out of the vessels.

There are other factors beside pressure which co-operate to assist in the formation of the clot in hemorrhage. The elasticity of the vessel diminishes the opening through which the blood escapes, and when a

large amount has been lost, all the blood-vessels contract to meet the lessened demand upon them, while the weakened action of the heart itself causes less distention of the vessels.

Moreover, when an *artery* is cut across, the inner coats contract and curl over inward sufficiently to entirely close small vessels and to not only diminish the size of the opening in large ones, but to afford a projection inward upon which the fibrin may catch and form a clot. The projection of the inner coat also strengthens the clot. Obviously the inner coats cannot turn in unless the vessel is completely severed, so that a partially cut artery is more dangerous than one completely divided. Severe bleeding is thus sometimes checked like magic by the simple dash of a knife, completing the division, the inner coats, loosened, promptly turning back and closing the vessel. Vessels of considerable size may be closed in this way by being pulled and twisted, as sometimes occurs in the large torn wounds occurring in railroad and machinery accidents. The clot formed in a vessel, if not disturbed, becomes "organized." Blood-vessels push their way through it and send out white corpuscles which are transformed into tissue cells, and in time the entire clot is transformed into scar tissue.

Treatment of Bleeding from Arteries. — In the treatment of arterial bleeding four classes of procedure are used: (*a*) twisting the vessel or "torsion," (*b*) tying or "ligaturing" the vessel, (*c*) position, and (*d*) pressure upon it in various ways.

Twisting or "torsion" occurs naturally, as has been remarked in certain extensive lacerations, and it is often resorted to by surgeons, particularly for the relief of bleeding from small arteries. With a small pair of forceps the cut end of the artery is grasped, pulled out, and twisted by a few turns of the forceps. The vessel is closed by the turning in of the inner coats.

Tying or "ligaturing" the vessel consists in passing a suitable thread about it and tying up the bleeding end. This is the proper way to permanently close any artery, except very small ones. The materials used for this purpose are a fine quality of silk, prepared catgut, silver wire, and a large variety of similar materials. The material used in each case is called a ligature.

To practise the methods of *twisting and tying* requires a knowledge of anatomy and surgery such as only a professional man can possess, and consequently these methods *are to be used only by a surgeon.*

Position, however, is very simple in its application, and can be learned without difficulty. Where the body is sound, there is a perfect balance of the circulation, with no greater tendency for the blood to settle at the lower points than at the higher. If this balance is broken by a wound of an artery from which the blood flows out instead of returning to the system, the blood follows ordinary physical laws — it goes down more readily than it goes up. Consequently the elevation

of a bleeding part as high as possible above the heart, renders it more difficult for the blood to reach the wound and lessens the bleeding. In a wound of an artery of the foot, the patient should be laid on his back and the affected limb raised; in a wound of the hand or upper extremity the patient should preferably be seated and the limb raised; similarly, a sitting or standing posture would be advisable in an injury of the head.

Fig. 101. — Applying position in the treatment of bleeding from a wound of the arm. Pressure with the fingers is also being used.

Pressure is the most commonly applicable of the methods of temporarily checking bleeding, and can be used with the greatest readiness by laymen. Pressure may be exerted (*a*) directly upon a wound, (*b*) in a wound, plugging, (*c*) upon an entire limb above the wound, or (*d*) upon the vessel itself above the wound.

(*a*) Where a wound is small, pressure may be made directly upon it either with a finger or by any other implement used for exerting such pressure without entering the wound itself. I have seen a considerable number of cases where death has been averted in wounds of arteries by simply pressing firmly upon the wound with a thumb or finger.

(*b*) Perhaps the most natural thing to do in case of a leak in anything is to put in a plug. A bleeding wound is a leak in the circulation, and the most natural thing to do in such a case is to put in a plug, and the most natural plug is the finger. The plug acts by producing pressure on the surrounding parts, thus closing the vessels. It is held by many surgeons that this method alone is the best to be taught to troops in general for the emergencies of the battle-field. In 1859, a young Austrian soldier in whom the great artery of the thigh had been wounded, controlled the bleeding for four hours by firmly plugging the

wound with his thumb; if he had not done this, but a few moments would have sufficed to launch his soul into eternity. The hand, however, is liable to tire, and this treatment may be made more permanent by substituting some clean, hard body covered with clean gauze, cloth, or paper and bound firmly into the wound by a bandage. It is well to have the plug so shaped as to not only fill the wound, but project beyond it, so that the encircling bandage will not constrict the person.

In the upper and lower extremities a more efficient method of arresting bleeding may be applied. This is closure of the bleeding artery by pressure upon it between the heart and the wound.

(*c*) The most primitive method of pressing upon an artery above a wound is by tying something, such as a bandage torn from clothing, a triangular bandage, a handkerchief, or even a rope, tightly about the limb. But it is practically impossible to get enough pressure in this way, so, picking up anything that may be at hand — a knife, a bayonet, a sword, a ramrod, or a revolver — and thrusting it under the bandage, by using it as a lever and twisting it about, it is possible to bind the limb so tightly as to entirely stop the circulation below it. Appliances for arresting the circulation in a limb by tightly compressing it in this way are called tourniquets. They may be improvised in this and other ways, and surgeons have them made expressly for the purpose. This particular extemporized tourniquet is often called the Spanish windlass.

Fig. 102. — The Spanish windlass extemporized tourniquet.

There are other methods of attaining this result more neatly by the application of elastic bands. If a bit of soft rubber tubing be at hand, nothing could be better; it may be applied by tying it strongly about the limb. The same result may be accomplished by the use of an elastic suspender, if any bystander happens to have one to spare. Surgeon-General Esmarch of the Prussian Army has availed himself of this principle in devising a pair of suspenders expressly for this purpose. It is composed of a long strip of elastic webbing so arranged that the tags by which it is attached to the trousers can be readily removed, leaving a simple elastic bandage — an elastic tourniquet of the most improved pattern.

If the bleeding is not too severe it may be possible to constrict the limb sufficiently by binding it firmly with a muslin roller bandage which may be made to shrink by saturating it with cold water. In the absence, however, of a rubber tube or an Esmarch's suspender, the twisted band or handkerchief would be better.

The great disadvantage of this class of methods is the complete stoppage of the circulation in the entire portion of the limb below the tourniquet. Where continued for a considerable time, serious troubles, extending even to gangrene or death of the limb, may ensue. If the circulation then can be arrested in the wounded artery alone without affecting the circulation in the rest of the limb, the same result can be obtained with far less danger to the patient.

(*d*) A readily available method of applying continuous pressure to a particular vessel is by applying a hard lump of some kind — a pebble or a cartridge, for instance — upon the vessel, and binding it on by a bandage tightened in the ways mentioned in the preceding class. This takes off the pressure on either side of the lump and allows a sufficient amount of blood to pass the obstruction to prevent strangulation of the limb. In Fig. 102 this method has been adopted in an extemporized tourniquet.

The surgeon's tourniquet utilizes this principle. It consists of a webbing strap with a buckle at one end, and attached to the strap a padded lump. The lump is applied over the artery and the strap is tightly buckled about the limb. The lump thus pressed upon the artery checks the circulation in the vessel.


Fig. 103. — The screw tourniquet.

The tourniquet, however, is subject to the same objection as the band drawn about a limb without twisting it — it is not tight enough. To obviate this difficulty, the screw tourniquet (Fig. 103) has been invented. It is applied in exactly the same way as the other, but when applied, it can be tightened to any degree by simply turning the screw.

A tourniquet which can be quickly extemporized, but which can be applied only to the arm, is Völker's stick tourniquet (Fig. 110). Two sticks from six to eight inches long, and from a half to three-quarters of an inch thick, are notched at either end; one is then laid directly across the artery of the arm and the other is applied to the other side of the arm parallel to the former. The ends are then tied firmly together. In this way the circulation in the great artery is arrested, while the collateral circulation of the small arteries running in the same direction on either side is not disturbed.

Another method of applying limited pressure consists in placing some hard body, such as a rod, a bottle, or even a stone, in the joint next above the bleeding point, and strongly bending the limb upon it (Figs. 112, 115). The limb may then be fastened in this position and so retained for a long time without damage. Where an extemporized method is necessitated, and this method can be used, as in the leg and in the upper extremity, it is probably the most useful; next to this, the twisted bandage with a lump.

In case of bleeding of any kind, presence of mind is of the greatest importance. It is rare that prepared appliances for arresting it are at hand. The mind must be capable of at once divining the proper action and of instantly executing it. The lump may be composed not only of a stone, but of a cartridge, a cork, a ball of any kind, a marble, a hard knot in a bandage or handkerchief, a small spool, or a firmly rolled mass of cloth, or even a strongly crumpled mass of paper. The band may be formed not only of a triangular bandage cravat, twisted or flat, but of a handkerchief, a roller bandage, strips of clothing, ropes, cords, belt, or any soft tough strip which can be firmly tied about a limb. On the battle-field arms, or fragments of arms, will be available for twisting the band, and in civil life sticks of various kinds, parasols and umbrellas, rulers and bottles, pocket knives and scissors, keys and canes, and innumerable substitutes which will be found at various places. The mind should be familiar with this fact, and should be prepared to adapt neighboring articles to the present emergency.

Bleeding from Arteries of the Head. — Owing to the fact that the entire *scalp* is underlaid by a plate of bone, there is no difficulty in deciding where to exert pressure in order to check bleeding there. Press directly down upon the scalp near the edge of the wound on the side from which the bleeding proceeds. The artery will not always be found at once, owing to its small size, but two or three trials will locate it without difficulty. Permanent compression may be exerted by laying a hard pad, extemporized from any available material, upon the point of pressure, and holding it in place with a bandage formed also of the most convenient substance. The shape of the head makes it sometimes a little difficult to tie on the bandage so that it will hold the pad firmly in place, but perseverance and a little ingenuity, particularly when reinforced by previous practice on the head of a friend, will always be rewarded with success.

Fig. 104. — Pressure with the thumb, controlling bleeding in the temple.

In case of a wound of either *temple*, the temporal artery below the wound should be compressed upon the bone (Fig. 104). It will be remembered that this artery runs up in front of the ear, and divides into two branches. Permanent compression may be

applied by means of the knotted turn of the roller bandage (page 106), a suitable pad being held in place under the knot.

The arteries of the face are mostly branches of the facial, which crosses the lower jaw about an inch in front of the angle of the jaw, where its pulse can be readily felt. (1) Bleeding can then be controlled by pressing the artery down firmly upon the jaw bone with the thumb, or, if it be desirable to make it permanent, a suitable pad may be applied instead of the thumb, and bound firmly in place by a bandage passing under the lower jaw and over the top of the head. (2) Temporary control of the bleeding may also be obtained in wounds of the cheeks or lips by passing the thumb into the mouth, and, grasping the cheek just below the wound, between the thumb and fingers, pressing the artery between them.

Fig. 105. — Pressure with the thumb, controlling bleeding from the face.

Bleeding from Arteries of the Neck. — When the large vessels of the neck are severed, as in "cut throat" or other wounds in that region, the utmost quickness in checking the bleeding is necessary to save life. A moment's delay may be fatal, for the blood rushes from these vessels in tumultuous torrents. All of the carotid arteries and most of their branches are large and important vessels. It should be remembered that the line of the carotid arteries extends from the mastoid process behind the ear down to the edge of the top of the breast bone. Without an instant's delay, in a wound of this kind, the vessel should be promptly pressed back upon the spine with the thumb, and held there until the assistance of a surgeon is brought. No attempt should be made to substitute a pad for the finger, for nothing else can be trusted.

Fig. 106. — Pressure with the thumb, controlling bleeding in the neck.

As the hemorrhage in the neck may proceed from the veins, and as this is almost equal in danger to that from arteries, it may perhaps be best in all cases to apply the pressure directly in the wound. It should be remembered, however, that there must be no hesitation or delay in applying the treatment, whatever it is.

Fig. 107. — Pressure back of the collar bone, controlling bleeding from the upper extremity.

Bleeding from Arteries of the Upper Extremity. — The course of the great artery of the upper extremity may be remembered (Fig. 113) as arising out of the chest; it runs over the first rib just under the middle of the collar bone (*subclavian artery*), passes thence to the inner side of the arm (*axillary artery*), running do along the inner edge of the biceps muscle (*brachial artery*) to the middle of the elbow, just below which it divides into two main branches (*radial and ulnar arteries*), which course down either anterior edge of the forearm, and form two arches in the palm of the hand (*palmar arches*).

Fig 108. — The handle of a door key padded for pressure under the collar bone.

If the injury be in the *armpit*, the artery must be compressed either under the collar bone or in the wound itself. (1) To compress the artery under the collar bone, the thumb should be thrust strongly down behind the middle of the bone until the pulsation of the subclavian artery is felt, when the pressure should be continued until the blood ceases to flow. The subclavian is not easy to compress, and this manœuvre should be thoroughly practised upon one's friends. If a surgeon can be got within a reasonable time, the pressure of the thumb should be maintained until his arrival. If, however, some

considerable time must elapse, the thumb, even of the strongest man, will become tired and powerless, and a substitute for it will be desirable. In this case the handle of a key or any similar article, suitably padded, may be slipped down under the thumb and applied upon the artery. (2) Pressure in the wound is performed by pushing the thumb forcibly into it, and pressing the parts strongly against the arm bone.

If the injury be in the *arm*, the bleeding may be checked by compression of the subclavian, as described above, and by pressure upon the brachial artery in the wound itself or in the arm. Aside from pressure in the wound itself, (1) pressure of the artery with the fingers against the arm bone is the most readily applied. The arm should always be raised in cases of this kind, as shown in Fig. 101.

Fig. 109. — Pressure upon the artery above the wound, controlling bleeding from the arm.

(2) Völker's stick tourniquet (Fig. 110) — composed of two sticks six to eight inches long, a half to three quarters of an inch thick, and notched at the ends, which are bound together by any available material — is an excellent means of exerting permanent pressure upon the artery of the arm.

(3) A tourniquet extemporized from a handkerchief, a bandage, or any similar article, as described on page 151, — particularly when supplied with a pad to press directly upon the artery (Fig. 102), — is of the utmost value, and perhaps the most valuable extemporized means of checking bleeding from the arm.

Fig. 110. — Völker's stick tourniquet for pressure upon the artery of the arm.

(4) Where a screw tourniquet can be had, it should be used in preference to the other appliances, provided the artery can be located readily.

The foregoing demand some knowledge of the course of the vessels, and, while they are the best for the patient, yet it often occurs that those who are obliged to render first aid are not at all familiar with anatomy. In this case, methods not demanding such knowledge may be used, but it should not be forgotten that where a limb is tightly surrounded by any band, it is likely to become strangled and permanently injured. Still, where a life is at stake a certain amount of risk must be taken.

Fig. 111. — The screw tourniquet applied for controlling bleeding of the arm.

(5) Rubber tubing, elastic bandages, and the like are available here as well as in other extremities, and can be used when obtainable with the greatest advantage.

(6) A rod of wood, a base or billiard ball, and other articles of the kind, when pushed strongly into the armpit, form an excellent means of checking bleeding from the arm, if the limb be strongly bound down to the side, so as to compress the artery closely against the bone (Fig. 112).

In case of a wound at the *elbow*, all the procedures prescribed for the arm are to be applied.

If an artery in the *forearm* be wounded, in addition to pressure in the wound itself, (1) the methods employed for the arm and elbow may be used; for if the arm be so bound that the blood cannot pass below the arm or elbow, it certainly cannot issue from the forearm. (2) A readily applied method consists in placing a hard body, such as a cane, a small bottle, a rod from a tree, or any similar article in the elbow, and strongly bending it upon it: this may be made permanent by bandaging the forearm strongly to the arm (Fig. 115).

Fig. 112. — Pressure upon the artery of the arm by a ruler in the armpit.

If the injury be low down, particularly in the *wrist*, in addition to methods in the arm and elbow, bleeding may be

checked by pressing the wounded artery strongly upon the forearm bones. However, in this case, it is better to apply the pressure in the arm or elbow; for, on account of the large palmar arches, the blood will spurt out of both ends of the divided artery. Pressing the artery on both sides of the wound, however, will arrest the bleeding and, as well, pressure in the wound itself.

In the *palm of the hand*, the same condition exists, and pressure must be exerted either in the arm or elbow, or both forearm arteries must be compressed. Bleeding here can, however, often be controlled by grasping some hard object, like a billiard ball, or a smooth stone, or, in emergency, even an apple or a potato, in the palm: the pressure may be made permanent by bandaging the hand strongly in this position.

Bleeding from the *fingers* can always be controlled by pressure in the wound or above it, with the finger, or any other means of applying it.

Bleeding from the Arteries of the Body. — In bleeding wounds of the chest and abdomen, pressure should always be exerted in the wound itself, with a single exception. The exception is the case of a wound of one of the intercostal arteries, running along the edges of the ribs, and rather inside of the chest, so that the pressure upon the bone must be exerted from within outwards. To effect this, make up a little roll, preferably of antiseptic gauze, or of any other clean cloth, and tie it firmly with a string; work the roll through the wound into the chest, and then pull upon the string forcibly enough to press the roll against the bleeding vessel upon the rib.

In other wounds of the trunk, the bleeding should be controlled by pressure in the wound, with the fingers temporarily, or with a hard lump or pad and bandage permanently.

Bleeding from Arteries of the Lower Extremity. — The arrangement of the arteries of the lower extremity is very similar to that of the upper extremity. A single large vessel (*femoral artery*) passes into the thigh, over the front of the hip bone, at the middle of the groin; it runs down the middle of the thigh, and in the lower portion passes through

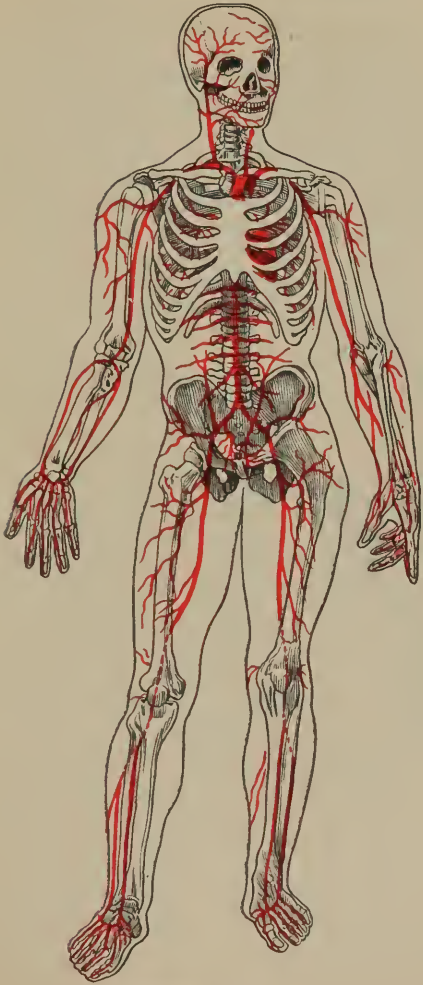

Fig. 113. — The arteries of the body, showing their relations to the bones at the points where pressure is to be made to control bleeding.

to the back of the thigh, where it runs behind the knee (*popliteal artery*), and, just below the joint, separates into two arteries, one of which runs down, skirting the lower edge of the internal malleolus, at the inner face of the ankle, to supply the sole of the foot (*posterior tibial artery*), and the other down the front of the ankle, to the top of the foot (*anterior tibial artery*). The artery is found near the surface in the groin and the upper part of the thigh, the back of the knee, the outer side of the heel, and in the front of the ankle. These points are naturally the proper localities for the application of pressure to check bleeding.

In case of bleeding from the arteries of the *thigh*, (1) the great femoral artery must be compressed in the middle of the groin, against the hip bone. Wounds of this artery are rapidly mortal unless immediate treatment is applied. *Delay is fatal!* Like the subclavian, it is very difficult to compress, and both thumbs should be applied upon it with all the force possible. If the arrival of a surgeon — who should be summoned immediately — is delayed, a substitute should be provided in a tourniquet, extemporized or prepared. (2) The Spanish windlass (Fig. 102) — a lump, suitably padded, being applied directly upon the artery — may be used. (3) An elastic band or a rubber tube is useful here as in other places. A screw tourniquet, with the pad upon the artery, is of service. (4) A pole, extending from the ceiling to the bed, may be so arranged — one end pressing upon the ceiling and the other upon the artery — as to hold the flow of blood in check. (5) Compression by the finger in the wound is here of value as well as elsewhere, and the only objection to it is the liability to soil the wound with matters clinging to the thumb.

Fig. 114. — Pressure upon the artery of the thigh by the thumbs, to control bleeding below it.

Bleeding from the back of the *knee* or *ham* proceeds from

the popliteal artery, a continuation of the femoral, and it must be controlled by precisely the same manœuvres as bleeding from the thigh, — compression of the femoral artery in the middle of the groin, or pressure in the wound.

If the injury involve an arterial wound of the *leg*, (1) the bleeding may be controlled in the same way as that of the thigh and ham. (2) It may be checked for a short time by bending the leg strongly back on the thigh, but this position cannot be maintained long on account of the resulting weariness to the patient. (3) But the application in the ham of a pad, such as an ordinary base ball, or an apple, potato, or even a stone of a similar size and shape, with the leg strongly bent upon it, will control the bleeding without the insufferable weariness. A rod, such as a cane or umbrella, a branch from a tree, or anything of the kind should be passed under it, and supported strongly upon it by a bandage passing about the bent limb. (4) The finger in the wound may be used here also, subject to the objection of being a possible conveyer of infection.

Fig. 115. — Pressure by a pad in the hollow of the knee with a rod, to hold it in place, controlling bleeding in the leg and below.

The *foot* is supplied by three arteries, all of which, like those of the hand, communicate so freely with one another, that, as in the hand, it is usually best to apply the pressure directly upon the wound. This may be done first by the thumb, and later by a suitably prepared pad and bandage. The foot is peculiarly adapted to treatment by elevation, the patient lying on his back; and it is well to apply all treatment with the foot lifted up. Bleeding from a wound of the *sole of the foot* may usually be controlled by pressure upon the posterior tibial artery, just below the internal malleolus, applied in the usual way. If the bleeding is not checked, pressure added upon the anterior tibial in front of the ankle will generally stop the bleeding; and if this is not successful, the peroneal, a small artery on the outer ankle, may also be subjected to pressure. This will control the bleeding in the

most extreme cases. If the *back of the foot* be the seat of injury, the anterior tibial in front of the ankle should be compressed first, and then the others as needed (Fig. 116).

Bleeding from Wounds of Veins. — Venous bleeding in general is comparatively free from danger, although a wound of one of the great veins of the neck (*jugulars*) in "cut throat" is a condition to be feared nearly as much as an arterial wound. Other large veins, especially in the extremities, accompany the arteries, and although they are often injured at the same time, the veins may be divided alone. Not uncommonly, superficial veins, particularly in the leg, become greatly enlarged, and form twisted, knotted ridges

Fig. 116. — Pressure at the inner side of the ankle, controlling bleeding in the foot.

under the skin: these are varicose veins. Injuries to them are equal in danger to those of veins normally greater in size.

It will be remembered that veins are provided with frequent valves, which prevent the return of blood from the heart. In large veins, however, it often happens that the valves are absent, or incompetent, so that in case of a venous wound,

the blood will flow from both ends of the divided vessel. In varicose veins the valves are, by disease, rendered useless, so that in case of a wound or rupture the blood will escape freely from both directions.

It will also be recalled that veins are very flaccid and easily compressed, so that but little pressure is needed to control bleeding from these vessels.

To control bleeding from any vein, then, a method which would compress both ends at the same time is desirable; and this is found in the method of *direct pressure in the wound* itself. It is accomplished by pressing firmly with the thumb at first, in order to hold the bleeding in check temporarily. Then, a suitable pad having been provided, it should be bound upon the wound firmly enough to restrain the bleeding permanently.

Any tight article of clothing which binds the body between the injury and the heart — since it may interfere with the return of the blood — should be loosened. Garters should be removed, belts should be unfastened, and collars should be taken off, so as to allow the blood free flow toward the heart.

And the application of elevation to all venous wounds should not be forgotten.

Bleeding from wounds of veins may be controlled, where the valves are intact, by simple pressure upon the vein below the wound — between the capillaries and the wound. This method of treatment is advised by many authorities, and may be used with advantage where it is absolutely impossible to find clean materials for a pad — which will be rarely. Indeed, pads above and below the wound may be used to control vein injuries where the blood comes from both ends of the vessel.

Bleeding from Wounds of the Capillaries. — This is the variety of bleeding most frequently seen when blood, not so bright as that in the arteries nor so dark as that in the veins, oozes from a small wound. Capillaries are so generally present in the tissues that capillary bleeding is present in all wounds, even though injury of larger vessels may mask it. It may vary in severity, sometimes oozing very slowly, as when a bit of scarf skin is scraped off, and again, flowing in

a considerable stream, as when a finger has been cut with a pocket knife. It will be found in scratches, pricks, and slight cuts of all kinds, whether from the careless use of the razor, a slip of a knife, accidental contact with broken glass, or similar accidents.

The treatment is simple. Mere exposure to the air for a few moments, with no other treatment, will often see capillary bleeding completely checked. The exposure causes contraction of the open vessels and clotting of the blood, which, together with the small amount of blood pressure, renders it possible for plugs of blood clot to quickly fill them.

Hot water, as hot as it can be borne by the patient, is one of the most valuable and efficient means of controlling capillary bleeding, and is often used by surgeons to diminish the flow of blood during operations. It may be applied by squeezing out a sponge or a mass of cloth, as shown in connection with the cleansing of wounds (page 136).

Extremely cold water has a similar effect to hot, although it is not quite as satisfactory in its action. Ice or ice water may be used with advantage for the relief of capillary bleeding.

The pressure of a pad directly upon the bleeding part is also of advantage in controlling capillary bleeding. In this case the pad may well be wet with hot or cold water before binding it tightly in place.

The use of styptics, such as perchloride of iron, Monsel's solution, tannic acid, styptic cotton, and the like, should be absolutely discouraged in any kind of bleeding, on account of their interference with the process of healing. The application of cobwebs or tobacco to bleeding surfaces is still more objectionable, — the first, on account of its liability to introduce not only dirt but disease-producing germs; and the second, on account of the danger of absorption of its poisonous constituent, nicotine. If a styptic is really needed, a little alum dissolved in clean water may be used, particularly in bleeding from the mouth and nose.

Spitting of Blood. — The discharge of blood from the mouth is commonly known by this name, although it may be due to a number of different causes, and proceed from a number of sources.

(*a*) Blood may come from the mucous membrane of the

nose, and run down through the posterior opening of the nose into the mouth. In this case, the blood can be felt passing down into the mouth; and the treatment is the same as that for nosebleed.

(*b*) Blood may come from the mucous membrane of the *mouth*, and particularly from the gums. Slight bleeding of this kind is of no moment, and will quickly recover without treatment. At other times it continues so long and is so abundant as to be annoying in the extreme. In this case, filling the mouth with fluid as hot as can be borne, thus bringing it in contact with every bleeding point, is of advantage. Hot coffee or tea are as good as hot water, and are more agreeable to some. Pieces of ice in the mouth are also useful. Here alum can be used with advantage in a strong solution washed about the mouth. In the absence of alum, a strong solution of salt in water is of value, used in the same way. In case of bleeding from the cavity left after the extraction of a tooth, a plug of cotton saturated with either of the two latter agents may be of advantage.

Severe bleeding from the tongue or the inner surface of the cheek may require to be controlled by pressure, which is best applied by pressing a pad directly upon the bleeding point with one finger, and supporting the opposite side with a thumb or another finger.

(*c*) Blood may come from the *throat*, and in this case either the windpipe or the gullet may be injured. It is not practicable to apply pressure directly here, and the treatment should be confined to placing the patient in a lying-down position, and keeping him as quiet as possible. If the bleeding is considerable, and ice is obtainable, he should be made to swallow a considerable quantity pounded into pieces the size of a pea.

(*d*) Bleeding from the *lungs*, "pulmonary hemorrhage," is caused by the breaking of a vessel in the lungs, and is accompanied by coughing, with rattling in the chest, while the blood itself is frothy and bright red. The break in the vessel is usually produced by the advance of consumption, although it may be due to a splinter from a broken bone sticking into the lung, or a wound due to any other cause.

A physician should be called at once. While awaiting his arrival, the patient should immediately be made to lie down, with pillows or their equivalent so placed as to slightly elevate the head and shoulders. Finely chopped ice should be eaten in this case also. If a teaspoonful or so of salt can be eaten with it occasionally, so much the better, or the salt may be dissolved in a little cold water, which may then be drank. The patient should be kept absolutely quiet, and while he should not be placed in danger of taking cold, the room should be kept very cool. If available, a quarter of a teaspoonful of spirits of turpentine may be given in a little cold milk every two or three hours. The patient should be kept in a darkened room, and no persons not essential for his care should be admitted, while every effort should be made to have as little noise as possible.

(*e*) Bleeding in the *stomach* is due to the breaking of a vessel in the stomach, and may be caused by an ulcer eating into the vessel, or other causes which might produce rupture of a vessel in any part of the body. Blood from the stomach is vomited up, is usually clotted and never frothy, is of a color extending from dark red to black, and may be mingled with masses of food. It should be remembered that vomiting of blood is not invariably caused by bleeding into the stomach. Blood from the mouth, or even the nose, may be swallowed and thrown up again.

The proper treatment in this case, after sending for a physician, is to make the patient lie down, with the head and shoulders slightly raised; keep him absolutely quiet, and feed him with chopped ice, and give him turpentine in quarter-teaspoonful doses in a little cold milk every two or three hours.

Nosebleed, "nasal hemorrhage," proceeds from the vessels of the mucous membrane of the nose, and, while it is usually of no moment, and stops spontaneously, it may be so severe and prolonged as to be very alarming. Usually, however, it need not be the source of the least anxiety, for a sufficient clot will readily form to hold it in check. If it be obstinate, cold water, or solutions of salt or alum, or even vinegar, may

be snuffed or syringed into the bleeding nostril. The arms may be lifted above the head — a procedure which is said to have been eminently successful. These having failed, the nostril must be plugged. The plug is best made of a long strip of cheese-cloth or old linen or muslin, a half an inch wide. With a pencil or a penholder, one end should be pushed into the nose as far as it will go; the rest of the strip should then be pushed in firmly and packed tightly, the end being allowed to hang out of the nose. To remove the plug, the strip may readily be drawn out by this protruding end. If the blood, dammed up in front, begins to find its way into the mouth through the posterior opening of the nostril, the plug has not been packed tightly enough behind, and it should be drawn out and packed in again. This plug should be kept in place for several hours, and when drawn out, the greatest care should be employed to prevent a renewal of the bleeding by too much force. If the dried blood has caused it to stick, it should not be pulled forcibly away, but should be loosened by warm water or oil.

Internal Bleeding in General. — In internal bleeding, the blood may escape into a closed cavity, such as the abdomen or cranium, and present no external evidences, or it may escape through an opening in the cavity, artificial or natural, as through a wound in the chest or abdomen, or through the gullet or windpipe, from the lungs or stomach. Bleeding into the cranium is most often caused by rupture of one of the minute arteries of the brain, and constitutes the accident known as apoplexy, which will be treated further in the chapter on Fainting. Bleeding into the chest, where the lung is not wounded, may fill up the cavity with blood, and press upon the lung so much as to seriously interfere with breathing. In any case, the paleness, small pulse, chill of the body, dizziness, and inclination to vomit, and other symptoms of bleeding are present, and demand the treatment due to shock in all cases, — a lying-down position, warmth in hot-water bottles to counteract the chill, and hot coffee or tea internally, except in case of bleeding from the lung or stomach.

Secondary Bleeding, or "recurrent hemorrhage," not as common now as before the advent of the antiseptic era in surgery, may be due to the renewal of strength in the circulation after severe bleeding, or to the ulceration of a blood-vessel. In the former case, the bleeding comes on within a few hours, but the latter may occur after several weeks. Where the bleeding is slight, it may be controlled by the addition of a little pressure upon the wound. If this is not sufficient, the dressing must be renewed, and the treatment proper to a fresh wound applied with great promptness. In severe secondary bleeding a surgeon should be summoned without delay.

Special Susceptibility to Bleeding is sometimes found in persons who are surgically known as "bleeders." In these persons, the least scratch produces alarming bleeding, and the extraction of a tooth has been known to result in death, by bleeding from the cavity. In such persons, the greatest care should be taken to avoid the occurrence of bleeding of any kind, and where the accident does occur, no delay should be made in applying temporary treatment and summoning a surgeon.

CHAPTER XIX

SPRAINS AND DISLOCATIONS

Sprains. — *Definition:* A violent twist or strain of the soft parts about a joint.

Causes: Any accident which may cause a twist or strain of a joint.

Symptoms: Great pain at the joint, following an unusual strain, such as a wrench or twist. Swelling about the joint rapidly follows. Discoloration similar to that produced by a bruise is apt to appear in the swelling. The bones are in their proper place, as seen by comparison with the same joint on the opposite side. The absence of signs of broken bones shows that that accident has not occurred.

Treatment: Place the joint in a position where it will have complete rest. Apply water as hot as can be borne freely about the joint, gradually increasing the heat, as long as it can be endured. Continue this for

half an hour, and then substitute ordinary hot, moist fomentations for another half-hour, and finally put the joint up in a wet bandage, keeping it well elevated. Consult a surgeon.

This affection invariably follows an accident. A man walking rapidly, steps into a hole, and is thrown down, with a turn of his body. His foot being caught, the twist comes upon his ankle, and he has a sprain of the ankle, where this accident is by far the more frequently situated. Next in frequency comes the wrist, which is sprained by a fall, the hands being thrown out to catch the body, or in other ways. Other joints — the hip, shoulder, elbow, knee, etc. — are less frequently affected.

The injury in a sprain depends to a great extent upon the inability of the ligaments to stretch when they are subjected to a strain. When a joint is wrenched or strongly pulled upon, the strain comes upon the ligaments, and they become bruised, and even torn. A small bit of the adjacent bone may even be torn off in a sprain. The same violence which has acted upon the ligaments is likely to act also upon the neighboring soft parts, the muscles, and even the skin. While in extreme cases, the bone and periosteum themselves are bruised.

It is evident that a sprain is apt to be a much more serious accident than would appear at first. While there are slight sprains which will require no attention, it should not be forgotten that *severe sprains are injuries of great importance*, and that permanent lameness has often followed a failure to give such an injury proper immediate care.

In sprains of the ankle, the entire foot and ankle should be plunged into water as hot as could be borne, and the heat should be gradually raised as high as possible without passing the endurance of the patient. In sprains of the wrist or fingers, the same course may be adopted. After continuing this from a half an hour to an hour, the part should be supported in an elevated position, — the foot placed on a chair, and the wrist in a sling, — and hot, wet cloths kept wrapped about it. After the first acute pain has subsided, in a day or so begin gently moving the joint, and rubbing it with soap liniment, oil, or vaseline; and kneading it gently at intervals.

Bones out of Joint. — *Definition:* The displacement of the end of a bone from its proper contact with another — a *dislocation*.

Causes: Those of sprain in a more violent form; a sudden wrench or twist sufficient to tear the ligaments, and allow the bone to slip out of place.

Symptoms: (1) The shape of the joint is changed. To ascertain this, the joint should be compared with that of the opposite side. (2) The limb is longer or shorter than that of the opposite side. (3) The relation of the limb to adjacent parts is changed. (4) Pain at the joint. (5) The patient cannot move the limb: this is an important factor in distinguishing a dislocated from a broken bone.

Treatment: Send for a surgeon instantly. While awaiting his arrival, place the patient in as comfortable a position as possible, supporting the injured side by pillows and pads in its new attitude, and surround the joint with hot moist fomentations. In most varieties of dislocation, although delay in treatment is harmful, uneducated handling is still more so; consequently they had better be left untouched.

Fig. 117. — Method of replacing a dislocated lower jaw. The upper diagram shows the relation of the bones in the dislocation.

Where, however, the services of a surgeon cannot be obtained for several hours, an attempt may be made to correct dislocations of the fingers or toes, the lower jaw, and the shoulder.

Dislocations of fingers can be reduced by strongly pulling on the finger, at the same time pushing the tip of the finger backward, if the end of the bone has slipped on to the back of its neighbor, or forward, if it has slipped on to the palmar face; and also pushing the dislocated end into its place. When returned to its proper place, the finger may be wound with a strip of sticking-plaster as wide as the finger is long.

Some dislocations of the finger are very difficult to reduce, and if success is not promptly attained by the method suggested here, the injury should not be irritated by further efforts. Dislocations of the thumb are very difficult to manage, and should be let alone.

Dislocation of the lower jaw occurs as a consequence of extreme yawning or laughing, and is a most embarrassing accident to the victim, who remains with his mouth fixed widely open, with the saliva dripping from its corners, and deprived of the power of distinct speech. In this case, wind a handkerchief thickly about both your thumbs, padding them sufficiently to prevent injury by the sudden closing of the mouth when reduced. Place one thumb on to the lower jaw on each side as far back as possible, and grasp the jaw between it and the fingers without. Then press firmly downward and backward, when the jaw will be felt to move quickly into place. The thumbs should be drawn out from between the teeth with the greatest quickness, or they will be in danger of being crushed between the jaws when the muscles, tired by their enforced extension, rapidly and involuntarily contract. Once replaced, the jaw should be kept in position for a while by a handkerchief, bound about the point of the chin and the top of the head, or a four-tailed bandage would answer better still.

Fig. 118. — Method of replacing a dislocated shoulder, by the foot in the armpit.

Dislocation of the Shoulder. — In this injury, in addition to the signs of dislocation mentioned in the beginning of this chapter, the elbow usually projects from the side, and the upper arm appears to be slightly lengthened. The arm cannot be moved, and there is great pain in the joint.

Make the patient lie down on a bed or couch, or on the ground — failing a better place. Roll a pad out of several handkerchiefs, or something else that will make a pad of about that size, and place it

in the armpit, to avoid injury, by your foot. Then seat yourself by his side, with your foot in a direction opposite to his; remove the shoe from your foot nearest to him; put your foot in his armpit; grasp his dislocated arm in both your hands, and, pushing your foot in his armpit, pull strongly on the arm, at the same time swinging it toward his body. A snap will usually be felt, and the bone will be found to have returned to its place. If one or two attempts at reduction by this method fail, further efforts should be left to the surgeon, who should have been summoned in any case. After the dislocation is reduced, the arm should be bandaged firmly to the side for a day or two, in order to give the torn and bruised parts an opportunity to recover.

CHAPTER XX

BROKEN BONES

Fracture. — *Definition:* A break in a bone.

Varieties: 1. Simple, when the bone is broken in a single place, and there is no opening to the surface of the body.

2. Comminuted, when the bone is broken into several pieces. A comminuted fracture may also be compound.

3. Compound, when, in addition to the break in the bone, there is an opening through the soft parts to the surface of the body. A compound fracture may also be comminuted.

Causes: 1. Direct violence, where some powerful force strikes upon the body at a certain point, breaking the bone there.

2. Indirect violence, where powerful forces strike upon the ends of a bone, causing it to break between them.

Symptoms: 1. A violent accident of some kind, involving either a fall of the patient or of some heavy body upon him.

2. Pain at a fixed point — the place of the fracture.

3. A crack may have been felt or heard by the patient when the accident occurred.

4. The limb can be bent at that point, when it was immovable before.

5. The broken ends may be displaced by the action of the muscles, the ends having slipped past one another, in which case a limb would be shortened.

6. Upon gently feeling of the part, some irregularity of the bone will be felt at the painful point.

7. A crackling, called "crepitus" by surgeons, may be felt when the bone is firmly grasped above and below the painful point, and gently moved so as to cause the ends to rub upon one another.

Treatment: 1. SIMPLE FRACTURE. (*a*) If a surgeon can be gotten in a short time, place the patient in as comfortable a position as possible, supporting the injured part upon a pillow, or a similar pad made of clothing or other suitable material.

(*b*) Where a physician cannot be obtained, and where it may be necessary to move the patient any distance, further treatment may be attempted. Apply splints or some stiff material, properly cushioned, in such a way as to prevent the fragments of bone moving upon one another.

(*c*) If there is a prospect of several days elapsing before a physician's help can arrive, replace the fracture and dress it as specified hereafter in connection with individual fractures.

2. COMPOUND FRACTURE. This is a most dangerous injury, and needs the most thoughtful care. It is to be treated like a simple fracture, and, in addition, the wound is to receive the treatment proper for such an injury.

By far the most common variety of broken bone is the *simple fracture*, in which there is no opening through the skin and other soft parts down to the break. It readily heals when properly treated, and is not in the least a dangerous accident.

If, however, it is carelessly handled, and one of the broken ends is

pushed through the tissues to the external air, or an opening down to the break is made in any other way, it is transformed into a *compound fracture*, which, except under the most advanced surgical treatment, is an exceedingly dangerous injury, entailing prolonged illness, if not resulting in death.

On the other hand, careless handling may not push the bone through the skin, but may cause it to cut across a large blood-vessel or an important nerve, or in some way injure other tissues of importance, and in this way entail serious danger. Such an injury is called a *complicated fracture.* Since the bone may both push through the skin and produce these injuries, it is evident that a fracture may be both compound and complicated. It is hardly necessary to remark that the force causing the accident, and many other agents beside the bone, may render a fracture complicated.

When a powerful force falls upon any portion of the body sufficiently strongly to crush a bone into several fragments, producing a comminuted fracture, the same force is very liable to injure the soft parts about it to such an extent as to render the fracture compound, and then we have a compound comminuted fracture.

In some cases one end of the fractured bone is driven into the other, so that the fragments are wedged tightly together — this is an *impacted fracture.* The lack of an abnormal joint and of crackling in these cases makes their detection exceedingly difficult for the experienced surgeon, and entirely impossible for the amateur.

A bone may be completely or partly broken. The former is a *complete* and the latter an *incomplete* fracture. The incomplete fracture is often called a *green stick fracture*, owing to its resemblance to a break in a green stick, where the tough, green fibres break with difficulty. This fracture is never found in the brittle bones of old people, but often occurs in young children, where, owing to the larger proportion of cartilage or gristle, the bones are softer and tougher.

If you strike your wrist violently with a hammer, you will break the bone at the point where you strike — this is fracture by *direct violence.* But if you fall from a distance upon the palms, you will break one of the bones between the hand and the shoulder; this is a fracture by *indirect violence*, the violence being applied at the shoulder and the hand, and the break being at a distance from both points.

Cases sometimes occur where bones are broken by violent contractions of the muscles. The knee cap is very subject to breaking by muscular action: its fracture, in the great majority of instances, being due to the violent contraction of the great extensor muscular mass of the thigh. I saw a soldier a short time ago who, while playing football, missed the ball with his foot in an attempt to kick it with great force: by this act his leg was thrown forward so violently as to break his thigh bone at its middle; in other words, he kicked his leg in two by indirect violence.

The more important signs of fracture are the fact of an accident having occurred, pain at a certain fixed point, the ability to bend the limb or move the bone in an improper location, and the crackling felt or heard at the point of the injury.

All these symptoms may not be present in every case, for abnormal motion is absent in an impacted fracture, and it may be impossible to get crackling or crepitus, since other tissues may have gotten between the broken ends so as to prevent their rubbing together. And it is evident that there can be no crepitus in a green stick fracture, since the broken ends are not free to be rubbed together.

When a bone is broken, the blood-vessels of the bone itself and some of the surrounding soft tissues are broken, and a certain amount of bleeding occurs, followed by the formation of a blood clot between and around the broken ends. It takes about a week after the accident for this clot to be absorbed and carried off. During the second week a repair material called *callus* is thrown out about the broken points. It forms, in the case of long bones, a perfect sheath containing the two broken ends, and holding them in place; where the broken bone is hollow, callus forms in the medullary canal, and forms an internal support, further uniting the bone. A certain amount of callus also lies between the broken ends of bone, and acts as a sort of cement in causing them to hold together. The callus develops into cartilage, and after four to eight weeks into bone. The cartilage ensheathing and lining the bone, after about a year, disappears, being absorbed into the system; but that between the ends of the bone remains a permanent part of the bone, from which it is called *permanent callus.*

The indication for treatment of broken bones is *to bring the fragments into proper position and keep them there.* Any inflammation or other condition due to the injury is to be treated according to the needs of the particular case. The great majority of fractures occur in the limbs, and the general remarks upon the treatment of broken bones are applied to them. Fractures of the bones of the head and trunk are considered only where treated individually.

The injured point, if located in a part of the body covered by the clothing, should be uncovered and examined, due attention being given to the avoidance of pain to the patient by unnecessary movements in removing the clothing, and to the preservation of the clothing itself by unnecessary mutilation. Any limb may be neatly and satisfactorily exposed by carefully ripping up one of the seams in the garment covering it. Moreover, when the splint is to be applied, the flaps of clothing folded assist in the formation of padding for it.

The bringing the fragments of a broken bone into place, or "setting the bone," is called by surgeons "reducing the fracture." Where a fracture is complete, the ends of the bone are often drawn by the action of the muscles so that the ends overlap. To reduce a fracture,

then, it is necessary to pull the fragments in opposite directions until the ends can be placed end to end; this is accomplished in case of a fracture of the arm bone, for example, by having one person, with his hands in the armpit, pulling in one direction, while another, holding the forearm and wrist, pulls in the opposite direction. When the fragments are drawn out far enough, the ends should be worked into their position end to end.

It should not be forgotten that where the services of a physician can be secured within a few hours, and it is not necessary to move the patient, no attempts should be made to set the bone; but that meanwhile the fractured part should be pillowed in as comfortable a position as possible, and the patient kept perfectly quiet.

Splints. — The fragments having been brought into the proper relation, the next object to secure is their retention in that position until nature can complete the healing process. This is accomplished by fixing the broken limb to some stiff material which will not permit movements of the broken pieces. Such applications are called splints.

Four qualities are desirable in a splint: (1) It is absolutely necessary that the splint be composed of material sufficiently stiff to maintain the parts in position in spite of considerable tendency to displacement. (2) In order to properly support a broken limb, the splint must extend for some distance above and below the injury. And as the action of the muscles is liable to displace the fragments (Fig. 27), it is well to have the splints extend beyond the joints on either side of the injury, so that by making it impossible to bend the joints, movements of the muscles may be obviated. (3) It is desirable that the width of the splint should be as great and perhaps a trifle greater than the thickness of the injured limb. In temporary dressings, however, this is often impossible, and narrow articles, such as scabbards, ramrods, and broom-handles may be utilized in emergencies. (4) The surface of the splint which is to come next to the patient should always be cushioned with some soft and more or less elastic material to obviate irritation from an unyielding surface.

It is generally best to have two splints, one on either side of the limb, both held in place by the same bandage passed about them when in place.

In a hospital or in a surgeon's office may be found prepared splints, shaped to the limbs to which they are to be applied, and materials especially intended for the ready manufacture into splints. Among the latter are binder's board, felt, thin strips of wood glued to cloth, coarse wire cloth, and telegraph wire. Plaster-of-paris and similar bandages are used in the formation of permanent splints.

But in ordinary emergencies the resources of the hospital and the surgeon's office are not available, and such materials as are at hand must be adapted to the purpose. It is difficult to conceive of a place where something from which to extemporize a splint cannot be found.

It has been remarked that splints must be cushioned with some soft material on the side coming in contact with the injured limb, for an unyielding surface might induce inflammation sufficient to greatly increase the trouble. Materials suitable for this padding may be found wherever splints are required.

1. *In a Dwelling or its Vicinity.* — Small splints may be cut out from cigar boxes, and from ordinary pasteboard boxes, although the latter are usually so thin that several thicknesses are required; the binder's board, with which the covers of books are made, is excellent. Laths, shingles, and bits of wooden boxes of thin materials are good; while flour or sugar barrel staves are unsurpassed. Broom or mop handles, fire tongs, pokers and shovels; rulers from the desk; and many other articles may be found for this purpose.

The padding may be made from cotton, clean rags from the rag-bag, crumpled soft paper, crumpled soft muslin, linen, cheese cloth, or other fabrics.

2. *In a Shop or Factory.* — Tools and their handles, strips of leather belting, etc.

Padding may be made from cotton waste, fine shavings, tow, oakum, and many other materials.

3. *On a Public Street.* — Splints may be extemporized from umbrellas and canes, parasols, folded fans, and policemen's batons.

Padding may be made from bits of clothing, crumpled grass, cotton, and articles of that kind.

4. *In the Country.* — Splints may be found in branches, or sheets of bark from trees, bundles of rushes, straw or stiff grass, cornstalks, sugar-cane, and the like.

Padding here may be gotten from the leaves, hay, grass, soft bits of clothing crumpled, and other soft and elastic substances.

5. *On the Battle-field.* — Splints here are easily extemporized from weapons of various kinds, such as bayonets, knives, swords, and sabres and their scabbards, ramrods, rifles, picket pins, leather from saddles, and the like.

Padding materials are found here in grass, hay, crumpled clothing, saddle cloths, blankets, tow from the limber-chest, etc.

Splints may be held in place by triangular bandages in the broad or narrow cravat form, by roller bandages, which may be torn from sheets or shirts, and other articles of clothing. Pocket-handkerchiefs, napkins, towels, and scarfs make excellent substitutes; while even garters, suspenders, tape, cord, and straps of various kinds may be utilized. In fixing a splint in place, care should be taken to avoid bending the limb so tightly as to interfere with the free circulation of the blood in the part, and the tips of the fingers or toes should always be left uncovered, so that they can easily be felt, to see if coldness or a purplish color indicates interference with the circulation.

Great care is demanded in handling persons with broken bones, not only to inflict as little pain as possible upon the unfortunate victim, but to prevent further injury. The transformation of a simple into a complicated or compound fracture is an easy matter, but one fraught with evil consequences of the most dangerous description. Permanent disability — not to speak of death itself — has not infrequently resulted from the ignorant or officious treatment of broken bones. The lung has been injured by a sharp fragment of a broken rib, an artery has been sawn off by the rough end of a fractured bone, and other important organs have been and are liable to be affected in the same way.

In raising a fractured limb, it should be supported by a hand gently slipped under it, both above and below the injury, in such a way that there will be no tension on the break itself, and so that there is no bending at that point. If this be done with care, the limb may be moved with practically no pain. And the patient may be transferred to a litter or to a temporary resting-place, or splints may be applied without further displacement of the fragments. In applying splints, where possible the help of a second person should be utilized to support the limb while the dressings are being put in place.

Slings. — The slings made from the triangular and roller bandages should always be used when available. But sometimes they are not at hand, and other devices must be employed. The sleeve may be utilized as a sling; when it can be drawn on over the arm, it may simply be pinned to the breast of the coat; where it has been necessary to slit the sleeve, it may be drawn around under the arm and pinned to the breast of the coat also as a sling (Fig. 119). The front flap of the skirt of a coat may be used as a sling by turning it up and pinning it to the coat, or by cutting a small slit in one corner and buttoning it on to one of the buttons of the garment in front (Fig. 120). Two small handkerchiefs may be used for a sling. The first should be tied around the neck as loosely as possible, the knot being as near the opposite corners of the handkerchief as possible; the second should then be tied about the first in the same manner, and the forearm slipped through it.

Fig. 119. — A slit sleeve utilized as a sling.

Fig. 120. — Coat flap turned up and utilized as a sling.

Patients should not be alone. — A man who has received even so slight an injury as a fracture of the collar bone should not be left

alone, and certainly should not be permitted to go either to the surgeon or home unassisted. If able to walk, he should be helped; and if in great suffering or unable to walk, he should be carried on a litter or in other ways, as described in the chapter on carrying the disabled. The reaction from an accident is liable to be accompanied by dizziness and faintness, even to unconsciousness, so that if alone, a fall may aggravate the injuries already received.

The treatment required by fractures in various parts of the body differs in many respects, according to their location. The individual fractures, then, should be considered independently.

Fracture of the Skull. — *Causes:* Either the skull cap or the floor of the skull may be affected. The former are due to falls, where the head strikes the ground, and to blows upon the head. The latter — fractures of the base of the skull — are caused by falls, striking upon the feet or upon the lower end of the spine in a sitting posture, or they are sometimes due to blows upon the vault of the skull itself. In some instances comparatively slight violence will cause very severe injuries. I have seen cases where the skulls of boys have been frightfully caved in by a blow from a base-ball club, carelessly thrown behind him by the batter.

Symptoms: In a fracture of the skull cap there will be a large bruise, or more frequently an open wound, at the point struck. The bone will be movable or, if impacted, it will be depressed below the level of the skull. Fractures of the skull cap are almost always compound fractures.

In a fracture of the floor of the skull there would usually be bleeding from the mouth, nose, and ears. The discharge of a clear, serous fluid — the cerebro-spinal fluid — from the ear is positive evidence of a fracture of the floor. The blood may settle in red patches under the eye.

And in both cases there may be insensibility, with symptoms of stunning and of compression of the brain.

Treatment: Summon a surgeon immediately. Then carry the patient gently into a shady place, — a darkened room if possible. Lay him on his back, with his head and shoulders slightly raised, and keep him absolutely quiet. If there be an open wound in the head, it should be temporarily dressed with a wet antiseptic compress, as prescribed for the treatment

of wounds. Any tendency to heat or fever should be combated by cloths wet with cold water or bags of chopped ice to the head.

Fracture of the Nose. — *Causes:* A blow, a fall, or some crushing force, such as a wagon wheel running over the nose. The bones of the nose are prodigiously strong, and the violence must be very great to cause the accident.

Symptoms: The bridge of the nose is flattened down, or perhaps pushed to one side. The bones may be movable. Crackling or crepitus may be felt. The parts about the break soon display the signs of a bruise. The nose bleeds freely. The cartilage of the nose is fixed very firmly, so that it is rarely broken loose, although such accidents may occur.

Treatment: Treat bleeding by injecting hot water and plugging the nostril, as described in connection with nosebleed. Treat the bruise by moist fomentations, or a wound as directed for such injuries.

Fracture of the Lower Jaw. — *Causes:* The lower jaw may be broken by a kick from a horse or a man, by a blow with the fist, a club, or a bottle; by a heavy fall, striking on the chin, or by any similar accident producing direct violence.

Symptoms: The patient often feels the bone give way at the time of the accident; finds that he has not the power of moving it, and tries to support it with his hand. The gums are torn and bleeding, and the line of the teeth irregular. The broken fragments can be felt both in the mouth and from without, and crackling or crepitus can be felt on moving them. This fracture is often compound, opening into the mouth.

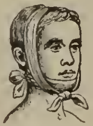

Fig. 121. — Treatment of fracture of the lower jaw with two triangular handkerchiefs.

Treatment: 1st method. With the hand, gently push the bones into place, and apply a broad cravat under the chin and over the head; then apply a narrow cravat in front of the chin, tying the ends behind the neck, and passing them under the first cravat on either side. The cravats may be made from triangular bandages or from ordinary pocket-handkerchiefs.

2d method. Make a four-tailed bandage (page 101) from a piece of muslin, of sufficient length to pass under the chin and over the head, or by cutting a pocket-handkerchief diagonally, leaving uncut a space about two inches long in the middle, and apply this like a four-tailed bandage.

Fracture of the Collar Bone. — *Causes:* A fall upon the outstretched arm or upon the elbow. A fall upon the shoulder. A blow or a fall upon the bone itself. The most common of fractures.

Symptoms: The shoulder drops downward and inward. There is loss of power in the arm, and the patient generally leans his head toward the injured side, and supports the elbow with the hand of his sound side. On running the finger along the collar bone, an irregularity can be felt, due to the projection of the outer fragment, the inner being pressed inward. Keeping one hand upon this point, and with the other raising the affected arm, abnormal motion is felt, and the irregularity is to a considerable extent removed; crackling or crepitus may also be felt.

Treatment: Remembering that the function of the collar bone is to hold the shoulder upward, backward, and outward, it is evident that the treatment needed to correct the deformity is to apply such apparatus as will accomplish the same end. (1) Make a good-sized pad, two or, better, three inches in thickness, and (2) thrust it high up into the armpit, (3) at the same time pushing the elbow as high up as possible, while keeping the arm as close to the side as the pad will permit. (4) Where triangular bandages are available, put on a large arm sling, so as to hold the arm high up in this attitude. (5) With a broad cravat, a scarf, a couple of handkerchiefs folded diagonally and tied end to end, or a roller bandage torn from some convenient material, bind the arm to the side. The pad for the armpit can with advantage be made wedge-shaped, three inches thick at its upper end and tapering to nothing below.

Fig. 122. — Treatment of fracture of the collar bone.

Fracture of the Shoulder Blade. — *Causes:* The fall of some heavy body directly upon the bone, by some crushing accident, by the kick of a horse, by a fall upon the back, and similar instances of direct violence. This bone is very rarely broken.

Symptoms: Inability to move the arm freely without pain. Great pain at the injured bone. Unusual irregularities in the bone. Movability of the fragments. Crackling or crepitus on moving them together. Swelling and other symptoms of a bruise at the point of injury.

Treatment: Apply a large arm sling, if a triangular bandage is available, or otherwise a substitute for it. Then bandage the arm to the side with a broad cravat or other bandage, as in fracture of the collar bone — the treatment being practically the same, with the omission of the pad in the armpit. The bruises on the back should be treated with cloths wet with cold water, and other applications, like bruises elsewhere, until the arrival of the medical man.

Fracture of the Arm. — *Causes:* A fall upon the arm or elbow. Direct violence, such as a laden wagon rolling across the limb. It may in rare cases be caused by violent contraction of the muscles.

Symptoms: The arm is helpless, and there is more or less change in its shape, shortening — if the fragments override one another — and an unnatural bending at the broken point, even where there is little shortening. The arm can be bent at an unnatural point, and at the same point — the site of the break — crackling or crepitus can be obtained. Fracture lying near the upper end of the bone is often very difficult to recognize.

Fig. 123. — Treatment of fracture of the arm.

Treatment: An attempt may be made to set the bone, one person steadying the shoulder by grasping with both hands in the armpit, while another pulls strongly upon the arm from below, and a third gently pushes the bones together with his

hands over the break. If the first attempt is unsuccessful, a second should not be made, but all future efforts should be left to a surgeon. Then (*a*) place a pad composed of a folded towel or handkerchief in the armpit. (*b*) Make two or more splints out of such materials as may be available — laths, book covers, picket pins, etc.; (*c*) carefully pad them, and (*d*) apply them about the arm, taking care not to draw the bandages or handkerchiefs too tightly, and yet tightly enough to hold the parts in place. The splints which are to be applied to the outer face of the arm may well extend to the top of the shoulder above and to the tip of the elbow below; while those that are on the inner side of the arm should be shorter. The object of the pad in the armpit is to avoid compression of the axillary nerves and blood-vessels by the inner splint. The forearm should then be well supported by a sling; but in this fracture, unlike that of the collar bone, care must be taken not to push the elbow up, as it would tend to displace the bone. The small arm sling about the wrist should be used alone.

Fracture at the Elbow. — *Causes:* A fall, striking upon the elbow. A blow upon the elbow.

Symptoms: The patient cannot bend his elbow. Pain is felt at the joint, accompanied, after a while, by swelling and heat. Crackling or crepitus may be felt on bending the joint.

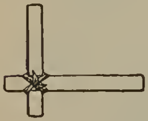

Fig. 124. — An angular splint.

Treatment: Take two straight splints, extemporized from any available source, and bind them together in the form of a right angle. Thoroughly pad the splint thus formed, and, applying it to the inner face of the arm and forearm with the thumb up, bind it securely in place. Support it in a broad sling, if available; in others, if not.

Fracture of the Forearm. — *Causes:* A fall or a blow.

Symptoms: One or both bones may be broken. (1) If both bones be broken, the usual symptoms — pain, an unnatural joint, and crackling or crepitus — will show the character of the injury very clearly.

(2) If only one bone be broken, the indications are not so evident. The finger should then be run along each bone to see if there is any unnatural motion or unusual projection; if an inequality is discovered, it is easy to determine whether the bone is broken at the point or not, by turning the hand around, when crackling or crepitus will be felt if there is a fracture there.

Treatment: Get or make two splints as long, if possible, as from the elbow to the tips of the fingers, and pad them well. Bending the elbow to a little more than a right angle, place the forearm with the thumb up. Then apply the two splints, one to the back and one to the face of the forearm, and secure them firmly with whatever means may be at hand. Support the forearm in the large arm sling, with the hand raised a little higher than the elbow.

Fracture at the Wrist. — It should be noted that this is not a fracture of the wrist proper, but of the lower end of one of the bones of the forearm — the radius. It has been called Colles' fracture, Barton's fracture, Pilcher's fracture, etc., from surgeons who have particularly investigated it. This is, next to fracture of the collar bone, the most frequent in the body.

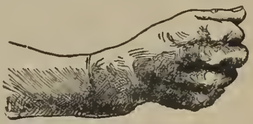

Fig. 125. — The deformity in fracture at the wrist.

Causes: The cause is invariably forcibly pressing the open hand backward, as in a fall, when the hands are outstretched to break the fall, or in attempting to push some heavy mass.

Symptoms: Pain at the point of the break. A deformity at the back of the wrist (Fig. 125), called the silver-fork deformity, from its resemblance to the back of a silver fork. On turning the hand about, crackling or crepitus may be felt, and the fragment may be seen to be movable, although they are more often firmly fixed, and the deformity is the chief symptom.

Treatment: If a surgeon can be gotten within a day, simply apply a small well-padded splint until his arrival. If some time must elapse, set the bones by forcibly bending the hand

backward and at the same time pushing the lower fragment forward. A surgeon would bind a broad strip of adhesive plaster about the wrist, which would be sufficient in the vast majority of cases to retain the fragments in place. But in an emergency, a small well-padded splint should be applied, extending from the fingers well up the forearm on the palmar face. Apply whatever sling may be convenient.

Fracture in the Hand. — *Causes:* Direct violence, in the form of a blow or a fall. The hand may be broken in games of various kinds and in fighting.

Symptoms: When one of the bones of the metacarpus forming the hand is broken, pain will be felt at the point, the fragments of the bone will be found to be movable, crackling or crepitus will be felt, and the knuckle with which the bone terminates will usually be sunken.

Treatment: Cut out a small splint from a cigar box, a bit of pasteboard, or something of the kind, having it long enough to extend from the tip of the fingers a little way up the forearm. Pad the splint well and apply it to the palm, taking care to have a thick wad of padding in the palm itself. Bind this splint in place, and put the arm in a sling with the hand rather higher than the elbow.

Fracture of the Fingers. — *Causes:* A blow or a fall — direct violence. An injury to which ball-players are very subject.

Symptoms: Pain, an irregularity at the broken point, possible motion there, crackling or crepitus, and swelling.

Treatment: The fracture in this case can easily be set. After this apply a small well-padded splint of cardboard, cigar box, or even a twig from a tree, extending from the tip of the finger up to the wrist; bind it firmly in place, and support it in a small sling.

Fracture of the Spine. — *Causes:* They may be indirect, from a fall upon the head, feet, or buttocks; or direct, either from the body falling across some projection or from some heavy article falling upon the body. These injuries are more frequent in railroad accidents and in mines and factories.

Symptoms: Paralysis of all that portion of the body below

the injury, due to compression of the spinal cord by the broken bone. Deformity may be felt upon gently running the tips of the fingers along the spine. But no attempt should be made to obtain motion, or crackling or crepitus, on account of the danger of still further injuring the delicate structures within the spinal canal.

Treatment: On account of the danger of increasing the injury, the treatment should be confined to placing the patient in as comfortable a position as possible, using the utmost precaution in moving him, to prevent injury. Apply hot dry fomentations to the body if cold, and send for a surgeon.

Fracture of the Ribs. — *Causes:* A blow or a fall upon the chest. Squeezing in a crowd has been known to break ribs, while in still other cases violent muscular action in coughing has produced a fracture. The fifth to the tenth ribs are the more frequently broken, while the eleventh or twelfth, the "floating ribs," are rarely injured.

Symptoms: The patient complains of a stitch at some point in the side, and his breathing is catching and in short breaths. Passing the finger over the painful spot, crackling or crepitus can usually be obtained, either by making the patient cough or by pressing with the thumbs alternately on either side of the break. In case the lung is torn by the sharp points of broken bone, which is frequently the case, there will be spitting of bright frothy blood. In many cases the symptoms are very obscure, and it cannot be decided whether there is a fracture or simply a bad bruise. In this case, the injury should be treated like a fracture.

Treatment: In ordinary fractures, it is considered that the bones must be kept absolutely quiet in order to heal properly. But in case of the ribs, this cannot be done without stopping the breathing, which will be impossible. However, the indication is to limit the breathing as much as possible, and this may be done by the application about the chest of two broad cravats of the triangular bandage. A broad flannel roller bandage carried firmly about the chest several times so as to cover it, is better still; while strips of adhesive plaster long enough to extend half-way around the body, and passed from

the spine to the breast bone, one overlapping the other, are better yet. The patient should be moved as little and as gently as possible, his chest and head being well elevated to prevent interference with his breathing.

Fracture of the Pelvis. — *Causes:* Great and direct violence, such as is incurred by the wheels of a heavily laden wagon passing over the hips, being squeezed between two railway cars, or being crushed by the fall of an enormously heavy weight.

Symptoms: There is a sense of falling apart, the patient cannot stand, and an attempt to rise produces great pain. Crackling or crepitus is sometimes felt. And a most important symptom is the fact of a tremendous crushing force having been exerted on the pelvis. Serious injuries to the bowels and bladder are apt to complicate this injury.

Treatment: Summon a surgeon instantly. Place the patient in a lying-down position, and pass a bandage about his pelvis. Handle him with the greatest care, and place him where he can have as nearly absolute quiet as possible.

Fracture of the Thigh. — *Causes:* Direct violence either through a fall of the patient or through a fall of a heavy weight upon his thigh. Indirect violence, through a jump from a height or a fall of heavy matter upon his body.

Symptoms: Differing somewhat, according to the location, the toes and foot are turned outward. There is pain at a fixed point. There is loss of power in the limb, which at the same time is shortened by the immense muscles of the thigh strongly drawing the lower fragment up with the leg. This is well shown in Fig. 27, page 32. The limb bends at an unnatural point, and crackling or crepitus may be obtained.

Treatment: This injury is one in which much depends upon the treatment. With proper care, it will progress to a perfect recovery; and on the other hand, with improper management, permanent lameness and even death itself may result. Much depends upon the gentleness and skill with which the limb is touched. In so large an injury it is easy, by injudicious or hasty movements, to convert a simple fracture into a complicated one, by allowing the sharp points of

the broken bone to thrust themselves through the tissues, or to pierce a blood-vessel, — accidents which may make it necessary to remove the limb. In all manipulations, then, employ the utmost gentleness.

First, summon a surgeon without delay. Then, place the patient in as comfortable a position as possible, preferably on his back, slightly inclined to the injured side, and with his head and shoulders somewhat raised. Then look about for material from which to extemporize a splint. On the battle-field, a rifle may be used. A board from a board fence will do well. Two billiard cues or a broom-handle will answer the indications excellently. These should be padded with clothing, blankets, leaves, grass, hay, or whatever may be available, and laid along the outer side of the injured limb. The limb should now be drawn out straight to its full length, and the splint bandaged to it by a bandage just above and below the break, with another about the waist and about the knee and the ankle. This done, additional support should be given the limb by bandaging it to the other limb.

Fig. 126. — Broom-handle used as a splint for broken thigh.

If a surgeon cannot be gotten within a day, more permanent treatment may be applied. Place the patient on a bed, with the foot raised five or six inches higher than the head. Then put a stocking and shoe on the foot of the affected limb, first having slit the shoe in the instep a quarter of an inch above the sole on either side, and passed a strap of leather or cloth through it. Fill a pail or bag with ten or twelve bags, six by three inches in size, filled with sand or earth; having fastened the strap through the shoe to one end of a cord and the pail to the other, pass it over the foot of the bed in such a way that the pail will not touch the floor, but hang suspended and constantly drawing upon the foot. In this way the muscles drawing the leg up will soon be tired, and the ends of the bone will gradually be drawn into place

and retained there. In a less primitive fashion this is the treatment now given a fracture of the thigh by modern surgeons.

Fracture of the Knee-Cap. — *Causes:* A blow or fall upon the knee; great and sudden muscular exertion, such as is caused by efforts to regain one's equilibrium on standing or slipping.

Fig. 127. — Separation of the fragments of a broken knee-cap.

Symptoms: Inability to move the limb or bend the knee. The limb is not shortened, and, upon feeling of the knee, one part of the bone will be felt pulled up by the thigh muscles, while another is left in place attached to the ligament, and there is a marked depression between them.

Treatment: Keep the leg straight, guarding against bending it, which would have a tendency to further separate the fragments. Place a splint of some kind — long enough if possible to run the entire length of the limb — on the lower extremity, bind it firmly at the ankle and the thigh, and

Fig. 128. — Splint and figure-of-eight bandage for broken knee-cap.

include it and the knee in a figure-of-eight bandage, which would tend to draw the fragments together.

Fracture of the Leg. — *Causes:* Direct violence: heavy bodies falling on the leg, kicks from horses, and the like. Indirect violence: heavy falls, jumps, and turns of the leg.

Symptoms: Pain at a fixed point, swelling and an alteration in the contour of the leg. On running the finger along the bone, a point of unnatural motion will be found, and at this point crackling or crepitus may be obtained. Where both bones are broken, the injury is easily detected, but where but one is affected, there is more difficulty, since the other bone forms a splint maintaining the limb in position.

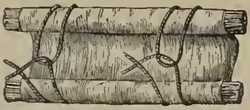

Fig. 129. — Bundles of straw or rushes as splints for broken leg.

Treatment: Lay the patient comfortably upon his back, and having provided two splints from whatever material is available, pad them well, and apply them to either side of the leg. The splints would preferably be a little longer than from the knee to the sole of the foot. On the battle-field, they could be extemporized from bayonets and other weapons; on the street, from canes and umbrellas; and in a house, from a host of materials. The padding may be made from clothing, bedding, hay, straw, and other materials used for the purpose. In civil life, a pillow can always be obtained, and if the leg is laid in it and splints applied on either side, we have a most satisfactory temporary dressing. Additional security will be contributed by tying the two limbs together.

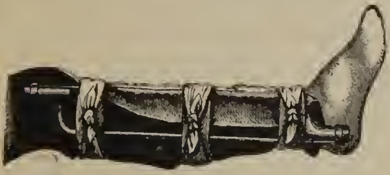

Fig. 130. — Splint extemporized from bayonets.

Fig. 131. — Pillow for fracture of the leg.

Fracture of the Foot. — *Causes:* Direct violence, such as is inflicted by a horse stepping on the foot, or by a wagon running over it.

Symptoms: Pain, swelling, and other symptoms of a bruise, an alteration in the shape of the foot, motion at an unnatural point, crackling or crepitus. These fractures are often compound.

Treatment: Uncover the foot and place it in a good position. Dress a wound, if it be present. Apply wet cloths to the bruised spot. Support the foot by an angular splint (Fig. 124), which may be improvised by a short and a long splint tied together, and applied with an abundance of padding to the side of the foot and leg. A surgeon should be consulted.

CHAPTER XXI

FOREIGN BODIES

Foreign Body in the Eye. — *Character:* Cinders from a railway locomotive; grains of sand and similar bodies blown about by the wind; bits of metal and grains of gunpowder.

Symptoms: Feeling the body in the eye. A copious flow of tears. Sometimes the body can be seen embedded in the cornea or conjunctiva.

Treatment: Close the eye for a few moments and allow the tears to accumulate; upon opening it, the body may be washed out by them. *Never rub the eye.*

If the body lies under the lower lid, make the patient look up, and at the same time press down upon the lid; the inner surface of the lid will be exposed, and the foreign body may be brushed off with the corner of a handkerchief.

If the body lies under the upper lid, (1) grasp the lashes of the upper lid and pull it down over the lower, which should at the same time, with the other hand, be pushed up under the upper. Upon repeating this two or three times, the foreign body will often be brushed out on the lower lid. (2) If this fail, the

upper lid should be turned up: make the patient shut his eye and look down; then with a pencil or some similar article press gently upon the lid at about its middle, and, grasping the lashes with the other hand, turn the lid up over on the pencil, when its inner surface will be seen, and the foreign body may readily be brushed off.

If the body is firmly embedded in the surface of the eye, a careful attempt may be made to lift it out with the point of a needle. If not at once successful, this should not be persisted in, as the sight may be injured by injudicious efforts.

After the removal of a foreign body from the eye, a sensation as if of its presence often remains. People not infrequently complain of a foreign body when it has already been removed by natural means. Sometimes the body has excited a little irritation, which feels like a foreign body. If this sensation remains over night, the eye needs attention, and a surgeon should be consulted; for it should have passed away if no irritating body is present.

After the removal of an irritating foreign body from the eye, some bland fluid should be poured into it. Milk, thin mucilage of gum arabic, sweet oil, or salad oil are excellent for this purpose.

Foreign Body in the Ear. — *Character:* Usually insects in adults, although other articles may find their way thither. Children may insert various small articles, including grains of corn, beans, buttons, and the like.

Symptoms: The foreign body, particularly if a living insect, may be felt by the patient. In most cases, however, it is not felt. It may be seen in the ear on examination. It may have been seen to be inserted.

Treatment: In case of a living insect, (*a*) hold a bright light to the ear. The fascination which a light has for insects will often cause them to leave the ear to go to the light. If this fails, (*b*) syringe the ear with warm salt and water, or (*c*) pour in warm oil from a teaspoon, and the intruder will generally be driven out.

If the body be vegetable, or any substance liable to swell, do not syringe the ear, for the fluid will cause it

to swell, and soften and render it much more difficult to extract. In a case of this kind, where a bean, a grain of corn, etc., has gotten into the ear, the body may be jerked out by bending the head to the affected side and jumping repeatedly.

If the body is not liable to swell, syringing with tepid water will often wash it out.

If these methods fail, consult a medical man. The presence of a foreign body in the ear will do no immediate harm, and it is quite possible to wait several days, if a surgeon cannot be gotten before.

It will be remembered that at the bottom of the external auditory meatus, about an inch from the opening, lies the tympanic membrane, a very delicate structure, which is essential to hearing. Very slight pressure is sufficient to break this delicate organ; consequently the insertion of button-hooks, hairpins, etc., into the ear in order to extract foreign bodies should never be attempted. I have known the tympanic membrane to be perforated and one of the small bones of the ear to be pulled out in an ignorant attempt to extract a foreign body, which a surgeon could have removed without the slightest difficulty. The technical knowledge of the surgeon is required here, and he will use instruments constructed for the express purpose of clearing the ear.

Foreign Body in the Nose. — *Character:* Usually small articles introduced by children, either into their own nostrils or that of their playmates.

Symptoms: The irritation of the presence of the body in the nostril. The obstruction to breathing. The sight of the body. The knowledge of its introduction.

Treatment: Close the clear side of the nose by pressure with a finger, and make the patient blow the nose hard. This will usually dislodge the object.

If this fails, induce sneezing either by tickling the nose with a feather or something of the kind, or by administering snuff.

The nasal douche, where a syringe or a long rubber tube suitable for a siphon is available, may be used in case the body is not liable to swell, injecting lukewarm water into the clear nostril with the expectation that it will push the body out of the other.

If these fail, and the body can be seen clearly, an effort may be made to fish it out by passing a piece of wire, bent into a little hook, back into the nostril close to the wall, and catching the body with it. A hairpin may be bent straight and the hook formed at one end. Do not continue these manœuvres very long nor let them be rough in the slightest degree.

All simple efforts having failed, send for a physician. There is no danger in leaving the foreign body in place for some days if it is impossible to consult a physician in less time.

Foreign Body in the Throat. Choking. — *Character:* Masses of food, bones, false teeth, etc., in adults. Coins, buttons, marbles, etc., in children.

Symptoms: Sudden difficulty in breathing, a distressing cough, retching, the face assuming a purplish hue, the eyes starting from their sockets, clutching at the throat, unconsciousness.

It is often difficult to tell where the foreign body lies. When it is possible for the patient to swallow, it is safe to presume that the body lies in the larynx or windpipe.

When the foreign body lies in the gullet, there is little or no cough, although swallowing is impossible.

When the foreign body lies in the pharynx, there is both coughing and inability to swallow.

Treatment: The common practice of slapping the back often helps the act of coughing to dislodge choking bodies in the pharynx or windpipe.

When this does not succeed, the patient's mouth may be opened and two fingers passed back into the throat to grasp the object. If the effort to grasp the foreign body is not successful, the act will produce vomiting, which may expel it.

A wire, such as a hairpin, may be bent into a loop and passed into the pharynx to catch the foreign body and draw it out. The utmost precautions must be taken neither to harm the throat nor to lose the loop.

In children, and even in adults, the expulsion of the body may be facilitated by lifting a patient up by the heels and slapping his back in this position.

Summon a physician promptly, *taking care to send him information as to the character of the accident*, so that he may bring with him the instruments needed for removing the obstruction.

Where there is no serious interference with the breathing, any action should be relegated to the surgeon. For, as a matter of fact, there may really be nothing in the throat, the impression of some body already swallowed remaining there. This often occurs in swallowing pills, a sensation as if the pill were in the throat not unfrequently continuing for a considerable time after it has passed into the stomach.

It may be impossible by any means to remove foreign bodies from the gullet or windpipe. A surgeon will, however, remove them from the latter, opening into it in the neck by a comparatively slight operation. If they are caught in the gullet, particularly if it be well down in the chest, a most serious operation may be demanded, requiring cutting into the stomach and reaching it from below.

When a foreign body, particularly one with sharp or rough edges, has been swallowed, do not give an emetic, for it will only increase any possible trouble. Make the patient eat freely of soft bread, potatoes, and similar starchy articles of diet, that they may surround the body with a mass of waste matter, cover its sharp edges and carry it safely through the bowels. Coins, nails, fragments of bone and the like may be carried through the bowels in this way with perfect safety.

CHAPTER XXII

FAINTING

Unconsciousness in General. — Sudden loss of consciousness is an accident frequently productive of the greatest alarm among bystanders, and deservedly so, for it is often the preliminary to a fatal illness. A very large majority of such cases are not dangerous, however, and they generally possess sufficiently marked characteristics to make it possible to distinguish them readily.

The *cause* of the insensibility often throws light upon the character of the trouble. If the patient has suffered a fall, striking upon his head, a depressed fracture would be proof positive of *compression of the brain*, while a similar fall, without any fracture and striking either upon the head or feet would indicate *stunning*. Fright, fatigue, loss of blood, and similar weakening occurrences would tend to produce *fainting*. Drinking freely of intoxicating liquors would cause *drunkenness*, while an irresistible tendency to sleep, after partaking of any suspicious medicine, would look like *opium or chloral poisoning*. Convulsions would suggest *epileptic fits, hysteria, or kidney disease*. A sudden insensibility in a person of advanced age after unusual physical or mental exertion would indicate *apoplexy*. Great weakness and depression, with or without unconsciousness, and following an accident or a sudden mental emotion, would suggest *shock*, while sudden loss of sensibility following exposure to long-continued heat would cause one to suspect *sunstroke*.

If, however, the cause of the injury be unknown and the patient be found in a state of unconsciousness, the diagnosis must rest upon other points. And in this case a systematic examination should be made, beginning with the head. Compression would be indicated by a depressed wound, while a simple bruise would look more like stunning. The eyes should be examined to see if they are sensitive to the touch, and if so, brain injuries could be eliminated; contraction of the pupils is a sign of opium poisoning, while unequal contraction of the two pupils is a characteristic of affections of the brain.

A glance at the face might discover that it is drawn to one side, in which case one-sided paralysis would be indicated, and pressure upon the brain either through a depressed injury, or apoplexy would be suspected. A bloated and flushed face is a sign of a hard drinker.

The odor of liquor or opium on the breath would be a sign of drunkenness or poisoning, while froth at the mouth and a bite of the tongue or lip would be present in cases of epileptic and other fits. The breathing is slowed in great weakness,

as in shock, and snoring in brain trouble, although it may be present in intoxication and poisoning by anodynes.

A very slow pulse is found in brain troubles; a very rapid pulse in sunstroke and other affections characterized by high fever, while a quick, thready pulse exists in great weakness, such as is present in shock.

Abnormal coldness of the skin is to be expected in freezing, while it is always found in intoxication and in collapse from cholera, etc. Great heat of the skin, on the contrary, is found in sunstroke and diseases accompanied by high fever.

Convulsions are present in epileptic fits, certain kidney troubles, hysterics, and in the indigestion and teething of children.

Other points of distinction may be learned by a careful study of the symptoms attending the individual affections.

Fainting. — *Definition:* A loss of consciousness due to a diminution in the circulation of the blood in the brain from a temporary weakening or stopping of the heart's action. Swooning. Syncope.

Symptoms: Sudden paleness of face and whiteness of lips. Cold sweat on the brow. Pulse greatly weakened. Breathing quickened. Muscular power weakened, causing patient to stagger and fall.

Treatment: Do not attempt to support the patient either in a standing or sitting posture. Lay him flat on his back with his head lower, if anything, than his feet. Let him have plenty of fresh air. Loosen tight clothing, such as collars and belts. Sprinkle the face with cold water. Apply smelling-salts to the nose if available. A glass of wine, or a cup of coffee, when consciousness has begun to return, will assist to give the patient strength.

Fainting is the variety of insensibility most frequently seen, and occurs in a number of conditions, in all of which, however, weakness of the heart's action is present. Hunger and indigestion, pain and fright, heat and fatigue, tight lacing, and bleeding may all cause it. The close warm atmosphere of crowds is especially apt to induce it in

the weak, and the fainting of one or more persons is an almost constant feature of large assemblages. Mental emotions acting upon the heart often produce fainting; bad news, and even good news suddenly received, often throws delicate people into a swoon.

Among soldiers, aside from bleeding, fatigue is the most frequent cause of fainting. It is a common occurrence on a long or forced march for men, especially recruits, to fall out of ranks and into a faint by the road. Where the man has suffered greatly from heat, the condition is apt to be much more serious, heat-exhaustion being added to fatigue-faintness and demanding special treatment.

The loss of consciousness is usually of very brief duration, although it may in exaggerated cases extend over several hours. The growing strength of the pulse, flushing of the cheeks and lips, and warmth of the fingers, indicate approaching recovery, followed by opening of the eyes and speech.

The main indication for treatment is to restore the blood to the brain. This will be assisted mechanically by laying the patient down with his feet higher than his head. If he be seated in a chair, or if he fall into one, nothing can be better than to tip him directly back in the chair; his feet will then be kept higher than his head without difficulty.

If bleeding be the cause of the accident, it is hardly necessary to remark that checking the flow of blood is the first thing to be done. Warmth should then be applied to the extremities and warm drinks administered.

When a person faints in an assembly where the seats are placed closely together, it may be convenient in some cases to cause the patient to lean forward with his head between his knees for a few moments, when he may have regained consciousness sufficiently to walk out of the room.

When the patient does not become conscious in a few minutes, a physician should be summoned without delay. Meanwhile, heat should be applied to the pit of the stomach, and diluted whiskey or brandy may be injected into the lower bowel — a tablespoonful of either, diluted with five or six times its bulk of warm water or milk. And if the heart is very weak and the breathing seems likely to cease, artificial breathing, as described in connection with Smothering, should be tried.

Shock. — *Definition:* A state of great nervous depression induced by severe injuries. Collapse.

Symptoms: Following an accident, a surgical operation, or a mental emotion such as grief or fright, the face becomes pale and pinched and assumes an anxious, frightened expression.

The patient is weak and faint, depressed and chilly.

The skin is cold and suffused with cold sweat, especially abundant on the forehead.

The pulse may be absent, and if present is weak, rapid, and irregular, while the breathing is sighing and irregular.

The eyes are dull and sunken, the pupils dilated and generally turned upward, while the finger-nails are of a bluish hue.

The condition is greatly like dying, and differs from fainting in the fact that the patient is not necessarily unconscious.

These symptoms are lessened in light cases and exaggerated in severe ones.

Treatment: Lay the patient at full length on his back, with his head low.

Loosen all tight clothing, — collars, belts, etc.

If there is bleeding or other causative conditions, control them. Dress wounds and bind up broken bones.

Rub the limbs and body, where uninjured, with flannel or similar substances, to restore the circulation.

Treat the coldness by hot, dry fomentations applied along his body and his extremities. A hot plate wrapped in a towel may be applied over his stomach, and bottles of hot water, hot flatirons, stones or bricks, may be applied to other parts.

Hot and stimulating drinks should be given him, under proper limitations. Hot coffee is always good. *If there is no bleeding*, whiskey or brandy in hot water or milk may be given, a couple of teaspoonfuls at a time. If the patient is so depressed that he cannot swallow, whiskey or brandy may be injected into the lower bowel, a tablespoonful in five or six times its bulk of warm water or milk. These doses may be repeated three or four times an hour until the patient is better.

In shock, as in fainting, the brain is deprived of its proper supply of blood — indeed, it is held that shock is simply another form of fainting, differing simply in being the result of mechanical injury.

The severity of shock varies greatly according to the person. A woman usually suffers less from shock than a man, although the weak, nervous, and timid suffer more than the strong, calm, and bold. The temperament of the injured person is almost as important a factor in determining the amount of shock as the severity of the accident itself. A plucky, determined man will endure a comparatively severe accident with less nervous depression than a flabby nervous individual.

The mind has considerable control over shock. Not a few instances are on record where men have endured severe surgical operations, and through their mental equipoise banished shock entirely. The instinct of self-preservation may also prevent or delay shock. Sir Charles Bell tells of a sergeant of the King's German Legion at Waterloo, who, after his arm had been torn off by a cannon-ball, close to his shoulder, without any dressing whatever, galloped fifteen miles to Brussels; but immediately upon arriving at the hospital he succumbed to shock and remained unconscious for a long time.

The shock may be so slight as to need no treatment, a natural and slight reaction setting in immediately. In the more severe cases the reaction is longer in coming and greater in amount. It appears with a quickening of the pulse and flushing of the cheeks, with brightening of the eyes and dryness and heat of the skin, — the characteristics of fever, — and should be treated during the time which it lasts in the same way as fever of any kind. In other cases, and these the more fortunate, the heart simply regains its normal strength, the body returns to its ordinary warmth, and the mind resumes its wonted vigor — the system simply returns to the natural condition.

A patient may suffer so severely from shock that reaction will not follow at all, in which case the symptoms will become more pronounced and gradually terminate in death. On the other hand, the reaction may be so violent as to produce congestive troubles, particularly of the brain, such as to render survival doubtful.

Stunning. — *Definition:* A condition of the mind, extending from bewilderment to insensibility, due to shaking of the brain by sudden violence. *Concussion of the brain.*

Causes: Blows or falls upon the head. Falls upon the feet, or the lower end of the spine as in jumping — in all cases the violence being transmitted to the brain either through the skull or spine.

Symptoms: (1) Slight stunning: — After a blow or a fall the patient is confused, bewildered, and giddy for a few moments, with the pulse possibly a little weak, the breathing slow, and the face pale.

(2) Moderate stunning: — After a blow or a fall, the patient lies insensible and immovable. His skin feels cold, his pulse weak and irregular, his eyes closed, and on examination his pupils are found to be contracted. May be aroused, but is peevish and falls back again into unconsciousness. After a time he becomes uneasy and tosses about, which is preliminary to recovery: if vomiting occurs, it is a sign of recovery.

(3) Severe stunning: — In this case the brain substance is usually torn and the symptoms are intensified. The patient cannot be aroused at all, the pulse is very weak and irregular, the skin is cold and clammy, and the patient is in a condition of marked shock, with a liability to excessive reaction. Death often occurs, and recovery is very slow, and liable to be complicated with acute congestion of the brain.

Treatment: (1) Slight stunning: — Rest, lying down with perhaps a cloth, wet with cold water, to the brow is all that is needed for slight cases.

(2) Moderate stunning: — Rest, lying down, the head somewhat raised, and perfect quiet maintained in order to enable the patient to sleep. Warmth should be applied to his extremities and body in hot water bottles, etc., as in shock. The head, on the contrary, should be kept cool by cloths wet with cold water, bags of chopped ice, etc. *Stimulating drinks should not be given.*

(3) Severe stunning: — In this case the treatment should be the same as that for moderate stunning, particular attention being given to keeping the head cool, on account of the liability to excessive reaction followed by inflammation of the brain.

Stunning is liable to be complicated with other affections of the brain. The most common are compression and inflammation of the brain. The former may be due to the bursting of a blood-vessel by a tear in the brain substance, which is likely to occur in severe stunning. The rupture is also liable to induce subsequent inflammation.

The extreme liability of the brain to excessive reaction after stunning absolutely prohibits the administration of alcoholic liquors which, themselves producing congestion of the brain, would greatly increase the danger of subsequent inflammation.

Compression of the Brain. — *Definition:* Pressure upon the brain substance, producing loss of brain power.

Causes: The skull may be broken and a fragment of bone pushed in upon the brain, a tumor may grow in the brain itself, a blood-vessel may have been cut, and the blood, running between the skull and the brain, press upon it; when this occurs, with or without an external wound, it produces apoplexy, which is considered on the next page.

Symptoms: Profound unconsciousness, even the eyes being insensible to the touch, while one or both pupils are dilated, but not uniformly.

The breathing is deep and snoring, with a puffing of the lips and cheeks with each breath.

The pulse is full, slow, and labored.

There is paralysis, more or less complete. The face may be drawn to one side.

The signs of a broken skull may be found in cases due to that accident.

Treatment: But little can be done for these cases except by a surgeon, who should be summoned at once.

The patient should be laid down with his head somewhat raised, and any clothing compressing the person should be loosened, such as the collar, suspenders, and belt.

Dress the wound with cold, moist dressings and apply cold to the head in the form of cloths wet with cold water, or ice bags.

Keep the patient quiet and in the dark, if possible. *Give no stimulants of any kind!*

Compression of the brain is apt to be mistaken for stunning, but a comparison of the symptoms given for the two accidents will make it possible to distinguish clearly marked cases. Stunning, however, is present in almost every case of compression, so that it is not often that we have a distinct case of the latter to observe. A doubtful case should be treated like one of compression, the more dangerous accident. Compression of blood from a bursted blood-vessel is called apoplexy, and is of sufficient importance to entitle it to distinct consideration.

Apoplexy. — *Definition:* Compression of the brain due to escape of blood between the skull and brain from a bursted blood-vessel. *Paralytic stroke.*

Causes: Sudden mental or physical excitement inducing distention and bursting of one of the vessels of the brain weakened usually by advancing age. The blood thus escaped forms a clot between the skull and the brain and presses upon the brain substance.

Symptoms: The subject is usually a person advanced in years.

The patient usually falls suddenly to the ground as if struck down.

In many cases he becomes unconscious at once, and when this does not occur, insensibility follows in a few minutes, and he cannot be aroused.

The face is flushed.

The eyes are insensible to the touch and irregularly dilated.

The breathing is slow, labored, snoring, and puffing, the cheeks being puffed cut during expiration and sucked in during inspiration.

Convulsive movements may occur.

There is paralysis of one side of the body, shown by lifting up the hands, when one will be found to be cold and lifeless, while the other is normal.

Treatment: Send for a medical man instantly.

Make the patient lie down with his head slightly raised, and keep him very quiet and undisturbed.

Loosen suspenders, collars, belts, and any tight articles of clothing.

Apply chopped ice or cloths wet with cold water to the head.

Apply warmth to the body and extremities by means of hot-water bottles, etc.

Give no stimulating drinks of any kind!

The cause of the bursting of the blood-vessel producing apoplexy is usually the softening and degeneration of the vessel due to advancing age. It most frequently affects persons over fifty years old. Anything which causes a strain on the vessels by overfilling them — such as joy or grief, bodily exertion or mental effort, a stooping posture, or a glass of wine — may burst the bleeding vessel. Younger persons, and even children, are occasionally attacked. Both physical indolence and mental activity render a man liable to it.

A form of apoplexy is caused by excessive congestion of the brain without bursting of a vessel. This variety is more likely to affect a younger class of patients.

Apoplexy is always alarming and dangerous. Many subjects, particularly the elderly, never arise from the first stroke. Younger and more robust persons may survive a number of recurrences. The third stroke is apt to prove fatal, although this is by no means invariable, for double that number have been endured in some cases. The immediate danger of the attack does not pass away in less than ten days, and a patient should be carefully watched for that length of time.

The paralysis due to apoplexy affects only one side of the body, and that the side opposite to the side of the brain injured. This is due to the fact that the nerves arising from the brain on one side cross to the other side to be distributed, as has already been described in the chapter on the Brain and Nerves.

The object sought in the treatment of apoplexy is the diminution and checking of the bleeding. Direct treatment of the bleeding point being impossible, general measures for quieting the heart's action and assisting the formation of a clot must be adopted. Anything which would be likely to increase bleeding should be strictly avoided, such as administering wines or liquors, lifting the patient into an erect posture, moving the limbs, or rubbing the skin.

Apoplexy has often been confounded with less serious troubles. "Drunk oı Dying," has been a frequent newspaper head-line to articles reflecting upon the police who have imprisoned a man suffering from a paralytic stroke, under the impression that he was "dead drunk."

Apoplexy may be distinguished from Drunkenness (1) by the fact that the heat of the body is raised in the former and lowered in the latter; (2) vomiting is common in drunkenness, and (3) the subject can be aroused to a greater or less extent by pinching, etc., while in apoplexy

there is no odor of liquor on the breath — this circumstance cannot be positively relied upon, however, since the subject himself may have taken a drink just before the attack, or the odor may arise from liquor which an officious bystander may have spilled in the effort to make him drink.

Apoplexy may be distinguished from Opium Poisoning (1) by the fact that the pupils of the eyes in the latter are contracted uniformly to fine points; (2) there is no paralysis, and (3) the patient may be aroused by shouting at him, while (4) there is a characteristic odor of opium upon his breath.

Apoplexy may be distinguished from Fits or Epilepsy (1) by the absence, in the latter, of one-sided paralysis, (2) by the foaming at the mouth, (3) by the spasmodic movement, and (4) by the short duration of the attack.

One form of *sunstroke* is actually congestive apoplexy, and should be treated like apoplexy. Other varieties of unconsciousness may be differentiated from apoplexy by a careful comparison of their symptoms with those of that affection.

Cases are liable to occur of most all of these affections which are so much like apoplexy as to deceive experts. In such a case the treatment should be that suitable to the most serious affection — an apoplectic stroke.

Drunkenness. — *Definition:* A state of more or less complete unconsciousness, resulting from drinking alcoholic liquor. *Intoxication. Inebriation.*

Symptoms: These vary from a simple state of exhilaration to a condition of profound stupor, when the patient is "dead drunk." The symptoms given refer to the latter stage.

Complete unconsciousness, from which the patient can be partially aroused.

Face flushed and bloated.

Eyes reddened and bloodshot; the pupils equally dilated and fixed: if the eyeball be touched, the patient will attempt to close the eye.

The lips are livid, and the breathing is slow and redolent with the odor of liquor.

The temperature of the body is lowered two or three degrees.

Treatment: Cold water dashed in the face often proves a most satisfactory awakener.

Cause vomiting by tickling the pharynx with a feather or something of the kind; by administering a table-spoonful of salt or mustard in a cup of warm water. Aromatic spirits of ammonia is very efficient in sobering a drunken man — a teaspoonful in half a cup of water.

A cup of hot coffee after vomiting will aid to settle the stomach and clear the mind.

Lay the subject in a comfortable position, applying hot, dry fomentations, if there is marked coldness.

While intoxication is particularly noteworthy, because of its liability to be confounded with apoplexy, — from which it is distinguished by the signs noted in connection with that affection, — it is a condition fraught with danger in itself.

Every one knows the effect of long-continued and often-repeated inebriation. The weak stomach, the enfeebled hand, the muscular trembling, and the shambling gait of the habitual drunkard are all familiar. But it is not so well known that alcoholic liquors taken in large quantities will cause fatal shock, — death occurring sometimes at once and sometimes within a few hours. These cases should be treated on the principles laid down for the treatment of shock.

The system of an inebriated person is particularly subject to the influence of cold. Nothing is more dangerous than to permit a man in such a condition to be subject to the influences of inclement weather, by lying exposed to rain, snow, or severe cold. The practice of confining a profoundly intoxicated man in a chilly and damp cell is very objectionable, for the same reason, — a fatal pneumonia or congestion of the brain is very likely to follow.

It is sometimes very difficult to distinguish between drunkenness and apoplexy, and where the shadow of a doubt exists *apply the treatment for apoplexy*. In such a case never cause the patient to vomit. The treatment for apoplexy is not ill-adapted to drunkenness, and certainly will not be harmful; while that for the drunkard might prove fatal to the apoplectic.

Sunstroke. — *Definition:* Unconsciousness, due to exposure to the heat, usually of the sun. *Heatstroke. Heat-exhaustion. Insolation.*

Causes: Exposure to long-continued heat — usually of the sun, but often to artificial heat in factories, etc., — is the chief cause; but bad air, excessive clothing, fatigue, and in particular intemperate habits are important accessories.

Symptoms: (1) Preliminary. In many cases the attack is preceded by giddiness, weakness, and nausea; the eyes becoming bloodshot, and the skin hot and dry.

(2) Preceded by these symptoms or not, the subject falls unconscious, the skin becomes exceedingly dry and hot, the breathing is quick and noisy, the pupils are contracted, and the heart is rapid and tumultuous.

Treatment: Place the patient on his back, with his head raised, in the coolest immediately available spot.

The chief object of all treatment is to reduce the excessive heat of the patient.

After removing his clothing, pour a stream of cold water over his body, holding the vessel four or five feet above him. First pour on the head, then on his chest and abdomen, and last on his extremities. Repeat until the patient becomes conscious.

Cold may be applied in other ways. Bags of cracked ice to the head and armpits should be used when available. The patient may be wrapped in cold sheets, or laid in a bath-tub which is then to be filled with cold water.

Continue the cold applications until the patient becomes conscious, or the heat is greatly diminished.

Renew it again at once if the symptoms arise again.

Heat-stroke seems to be an accident most common in the heated season in comparatively cool latitudes, or to persons who have not become acclimated in warm countries. Dampness seems also to have an important influence on the production of heat-stroke, the percentage of such accidents being greatly increased by an increase in the amount of moisture in the atmosphere. Fatigue is another important factor in the causation of heat-stroke. Soldiers upon a long march on a hot day are extremely subject to it. Heavy clothing should be avoided in hot weather, although, on account of their favoring the evaporation of sweat from the body, woollen garments are preferable. Any cause which weakens the system permanently or temporarily will favor the production of heat-stroke, and confinement in illy ventilated rooms and the use of intoxicating liquors are conspicuous among these.

The heat may cause merely a form of exhaustion, without insensibility, the patient complaining of great weakness and headache, while others are incoherent and stupid. These cases are to be treated with cold applications, and rest on the general lines laid down for severer cases, but less energetically.

Another variety, however, is more serious and demands entirely different treatment. In these cases the attack seems to direct itself upon the heart. The skin is comparatively cool, the face is very pale, and the breathing is sighing or gasping, while the pulse is rapid and hardly perceptible. The attack comes on with great rapidity, and the subject falls to the ground, gasps, and sometimes expires almost instantly. In these cases the shock of cold applications should be strictly avoided; warmth should be applied externally and stimulating drinks internally. The treatment which would save life in one case would be fatal in the other.

The treatment of the ordinary cases, however, is very simple, and consists in efforts to reduce the temperature of the over-heated blood. If the patient is in a close room, he should be laid near an open window; if he is in the open air, he should be placed in the shade where a breeze can reach him. All tight clothing should be loosened and as much as possible removed. If in a dwelling-house, it will be very convenient to place him in a bath-tub; out of doors, he can be laid on the grass, or the best available substitute for it.

In drenching him, the water may be gathered in a hat or bucket, or anything else that will hold water. A watering-pot is an excellent instrument for applying the water. After the heat has been reduced, the patient should be watched with the utmost care, and any rise in temperature should be promptly met by a renewal of the treatment.

An attack may be fatal at once, or it may last from a few minutes to forty-eight hours. Recovery is apt to be followed by permanent effects upon the system; the mind may be permanently weakened, or the patient may become a confirmed epileptic. A liability to frequent headaches and muscular spasms is a not infrequent result.

Insensibility from Poisoning. — *Definition:* Loss of consciousness from taking sleep-producing drugs.

Causes: Taking opium — including laudanum, morphine, paregoric, and its other preparations — chloral and anodyne mixtures.

Symptoms: Unconsciousness progressively increasing.

The pupils of the eyes are contracted to the size of a pin's point in opium poisoning.

The breathing grows progressively slower.

The smell of opium or chloral on the breath.

Traces of the poison, or the bottle from which it has been taken may often be found.

Treatment: Arouse the patient by slapping, pinching, and similar irritating proceedings

When aroused sufficiently to swallow, give the patient an emetic of mustard or alum, a tablespoonful to a glass of warm water. Continue the vomiting by repeated doses given again and again.

Make the patient drink freely of strong coffee.

Keep the patient awake by slapping him with wet towels, pinching him, talking to him, and even making him walk up and down until he no longer feels the intense desire for sleep.

The subject of opium and chloral poisoning is again referred to in the chapter on Poisons.

Insensibility from Freezing.—*Definition:* Loss of consciousness due to exposure to extreme cold.

Symptoms: Paleness and coldness of the frozen parts. Sluggishness of the pulse, slowness of the breathing, etc.

Treatment: Rubbing with cold applications in a cool but gradually warmed room. Stimulants and hot drinks as soon as the patient is able to swallow. Rest in warm clothing.

The subject of freezing in all its details has been fully discussed in the chapter on Bruises, Burns, and Freezing.

CHAPTER XXIII

FITS

Epileptic Fits. — *Definition:* Periodical convulsions, due to disease of the brain. *Epileptic convulsions. Falling sickness.*

Symptoms: Patient often utters a peculiar cry just before falling. Immediately becomes absolutely unconscious. Falls in violent convulsions, jerking the arms, legs, and body.

Foaming at the mouth, grinding of the teeth, and biting of the tongue or lips are common.

Face becomes livid, the eyeballs roll, and the pupils are unaffected by light.

Fit lasts from five to ten minutes.

Fit generally followed by drowsiness or deep sleep, sometimes by headache and debility.

Treatment: Nothing can be done to stop a fit.

Place the patient so that he cannot strike his head or limbs against anything likely to injure them.

Loosen the clothing about the neck and body to make the breathing and circulation as free as possible.

Tie a handkerchief between the teeth and about the back of the head to prevent the teeth closing upon the tongue.

Give the patient an abundance of fresh air.

Favor his tendency to rest after the fit has ceased.

Epilepsy is a disease of the brain which manifests itself in fits or convulsions, recurring at more or less frequent intervals, sometimes as often as two or three times daily. The victims generally experience premonitory symptoms, such as headache, dizziness, terror, or a peculiar creeping sensation like that of a current of air or a stream of water, beginning in a hand or foot and extending toward the trunk. Warned by these sensations, the subjects often attempt to place themselves in a situation favorable to the attack.

On account of the suddenness of the onset, however, it is often impossible for the epileptic to remove himself from dangerous locations. He may fall across a railway track, or down a flight of stairs, into a fire, or under water. In such cases, injuries of various kinds are likely to complicate the fit, and demand the treatment suited to them. If in a situation where his movements are likely to bring him into danger, it goes without saying that he should be removed.

Epilepsy is rarely cured. As life advances, the mind is likely to be affected to a greater or less degree. Nevertheless, a number of the great men of history have been subject to epilepsy. Cæsar and Napoleon, Petrarch and Byron, Mahomet and Paul, were victims of the disease, and achieved greatness in spite of it.

Hysterics. — *Definition:* Paroxysms, varying in extent from an uncontrollable fit of laughing or sobbing to convulsions similar to epileptic fits.

Symptoms: The subject is usually a weak girl or young woman.

May simply be affected with uncontrollable laughing or crying.

May fall suddenly to the ground, with clenched hands, grinding of teeth, and jerking of limbs, in imitation of epilepsy.

Partial unconsciousness is assumed, not real, as is shown by muscular resistance on attempting to open the eyelids.

The convulsions are never so directed as to hurt the patient, nor does she fall uncomfortably, nor bite her tongue, as in epilepsy.

There is no one-sided paralysis, no snoring breathing, nor flapping of the cheeks, as in apoplexy.

Treatment: No treatment is necessary. A patient will promptly recover, if left alone.

It is essential that no sympathy be shown.

A dash of cold water in the face, repeated if necessary, will complete recovery in most cases.

Hysterics must not be confounded with hysteria, which is an actual disease of the nervous system, demanding medical skill of the highest order for its treatment, and manifesting itself in a multitude of various symptoms.

Convulsions from Kidney Disease. — *Definition:* Paroxysms, due to blood poisoning, from the failure of the kidneys to cast off waste products.

Symptoms: Dropsy, particularly of the feet and lower limbs, existing some time previously.

Patient presents convulsions, varying from twitchings of the face and fingers to general severe jerkings of all the muscles of the body, with complete unconsciousness.

The breath and skin have a clammy odor.

The paroxysms may be preceded and followed by delirium.

Treatment: Summon a physician instantly, notifying him of the exact character of the trouble.

Place the patient in a comfortable position.

Apply cold, moist fomentations to the head — wet cloths or ice bags.

Apply a mustard plaster across the small of the back.

A previous history of kidney disease will exist in almost all cases of this kind and will help to distinguish it. It is not uncommon in women during the months preceding childbirth, and in this case it is fraught with great danger.

These convulsions are usually directly due to an alteration of the kidney by disease in which the excreting power of the urinary tubules is diminished, and the poisonous waste products, not able to be thrown off, are retained in the blood.

Children's Fits. — *Definition:* Paroxysms, due to irritation of the nervous system in children. *Convulsions of children.*

Causes: Constipation, indigestion, worms, eruption of teeth, fright, and similar irritating things. Convulsions are not as serious in children as in adults.

Symptoms: Before a fit, fretfulness, restlessness, and gritting of the teeth in sleep.

In a fit, the child is absolutely unconscious.

The muscles of the face twitch, the body stiffens at first and then passes into a series of jerking motions — the head and neck are drawn backward, and the limbs violently bent and straightened.

The pulse is very rapid and weak, the breathing hurried and labored, and the skin is wet with perspiration, often cold and clammy.

After a few minutes the child usually recovers in a quiet sleep, but the fits may be repeated with short intervals between them.

The first fit may be fatal, or later ones; or recovery may be prompt and permanent.

Treatment: A bath of water as hot as it can be borne should be prepared, a teaspoonful of mustard dissolved in it, if available, and the child should be set into it for several minutes, repeating the operation if the fit recurs.

Follow this with an injection of a little oil or a great deal of soapsuds to clear out the bowels, in case the cause of the trouble may lie there.

Then tickle the roof of the mouth with a feather, or use other means to produce vomiting, since the cause may lie in the stomach.

Summon a physician without delay.

CHAPTER XXIV

SMOTHERING

SMOTHERING, suffocation, or asphyxia is a state of unconsciousness due to cutting off the supply of oxygen to the lungs. Smothering may be due to a number of causes. The most common is drowning, where the water prevents the access of air to the lungs. Hanging and strangling, where the passage of air through the windpipe is prevented by compression of that tube, are well known. Anything which will close the air-passage will produce smothering; such are bits of food and other articles diverted from their proper channels in the attempt to swallow; a variety of croup, in which the windpipe is stuffed up by secretions, comes into this class. Pressure upon the chest sufficiently to prevent its movement in

breathing is another cause. The methods of Othello and Richard III., causing smothering by pressing a pillow tightly down upon the face, are classical. Smothering is the cause of death in persons who have been buried under avalanches of snow or sand, grain falls, and the like.

Another variety of smothering is that produced when the atmosphere is so filled with other gases that the proper amount of oxygen cannot find its way into the blood. Smothering by breathing air filled with illuminating gas is a common accident in cities where the victims from carelessness or ignorance have failed to turn off the gas in extinguishing a light. The gases formed by burning coal and decaying sewage, and the smoke of burning buildings, produce insensibility from the same cause.

The restoration of the function of breathing is the chief aim in treating cases of smothering — by this means carrying off the waste, poisonous products from the blood and giving new life to the system by an abundant supply of oxygen.

Restoring the Breathing. — The act of breathing is restored by causing the chest walls to expand and contract in the same manner as in the normal acts of inspiration and expiration.

Fig. 132. — Restoring the breathing by Sylvester's method — Inspiration.

This is called *artificial respiration* and is performed in several ways. One of the most convenient and useful is *Sylvester's method*, which is as follows: —

Lay the smothered person on his back, with a pillow of folded clothing or other articles under his shoulders.

Take a position at the head of the patient, grasp his arms just below the elbow, and draw them slowly and steadily up over the head, holding them there long enough to deliberately count four.

Then push the arms down upon the chest, bending the elbows as they come down, and press them strongly, but gently, against the chest long enough to again count four.

Repeat these movements until the patient begins to breathe naturally, or until it is evident that life is beyond recall.

Fig. 133. — Restoring the breathing by Sylvester's method — Expiration.

The first sign of returning breathing is a change in the color of his face; if white, it becomes red; and if red, it changes to white. With this a faint fluttering breath may be seen passing the lips.

Drawing the arms up over the head pulls upon certain muscles which expand the chest, creating a vacuum which the air rushes in to fill. Pushing the arms down upon the chest again compresses it and forces the air out of the lungs. Air is thus drawn into and forced out of the lungs in the same manner as breathing. The blood is gradually purified by the oxygen brought into contact with it, and the system is again inspired with life.

Marshall Hall's method was long the most popular method of restoring the breathing, and is still described at length and illustrated, in many works; in connection with the resuscitation of the drowning. It consists in laying the body on one side and rolling it on to the chest so as

to compress its walls and produce expiration, and on to the back, to permit the chest walls to spring out to their normal position, producing inspiration. The method is clumsy in requiring several assistants, and incomplete in that the amount of contraction and expansion of the chest is slight. Either Sylvester's or Satterthwaite's methods are vastly preferable to it.

Howard's method is better than Hall's. The patient is laid flat on his back with a roll of clothing under his shoulders thick enough to allow the head to be thrown well back, and his hands are tied together above his head. Then kneeling beside or astride of the patient, the operator places his hands upon the lower ribs, grasping the waist, and presses them in by throwing his weight upon his hands, at the same time pressing upward. Then he lets go with a push that brings him back to the kneeling position, the pressure producing expiration, and its removal, inspiration.

Drowning. — *Definition:* Suffocation through the stoppage of the air-passages by fluid.

Causes: The stoppage of the air-passages by fluid. Any amount of fluid will cause the accident, provided that it is sufficient to prevent the passage of air to the lungs. Men have been drowned in a basin of water and a tankard of beer, as well as in water fathoms deep — the immersion of the face being enough.

Symptoms: The chief symptom is the fact of the patient having been immersed in water.

Upon being taking out, the face is swollen and purple.

The lips are livid and the eyes bloodshot.

The mouth, windpipe, and lungs contain a frothy fluid, and there is considerable water in the stomach.

The tongue may be swollen and bluish, and grasped by the teeth.

The feet and hands also are often swollen and discolored.

The body is cold.

Treatment: 1. Summon a physician as soon as possible without leaving the patient in danger.

2. The treatment should be applied in the open air unless prevented by inclement weather.

3. The clothing should be rapidly removed, cutting with knife or scissors for the sake of haste, and the body quickly wiped dry.

4. (*a*) Wedge open the mouth and keep it open by tying a handkerchief or bandage through it like a gag. This will also help to keep the tongue in place. (*b*) Get rid of the water that is in the body, by rolling the person over on to his face, with his head a little lower than the body, if possible, and (*c*) then, getting astride of the patient, gently raise his middle by the hands clasped under the abdomen; in a few seconds the water will have run out sufficiently to permit the next step.

Fig. 134. — Emptying the water from the lungs.

5. *Restoring the Breathing.* (*a*) Turn him on to his back, placing him on level ground, and keeping the mouth wedged open as before. (*b*) Place the left forefinger on the tongue to keep it in place, and (*c*) with the right hand press upon the abdomen,

making the pressure toward the back and head of the patient. Press gently at first, but increase the pressure until as much air as possible has been forced out of the chest. (*d*) Then withdraw the hand so that the lungs may fill with air. (*e*) Repeat these movements, at first making them three or four times a minute, increasing to ten or fifteen, and persisting at that rate until breathing has been re-established, or it is evident that the patient is dead. This is *Satterthwaite's method* of restoring the breathing.

Fig. 135. — Restoring the breathing by Satterthwaite's method.

Where several persons are present to assist, Sylvester's method may be used in addition to this. The arms should be pressed upon the chest at the same time that the abdomen is pressed upon. When the hand is withdrawn from the abdomen, the arms should be brought up by the side of the head.

6. Wrap him in warm, dry clothing, blankets and overcoats, or other articles of clothing which can he borrowed. Then rub the limbs and body briskly under the clothing to assist in restoring the circulation.

7. A good healthy reaction of the system having been obtained, the patient may be carried to a comfortable room and placed in a warm bed. Hot dry fomentations, such as hot-water bottles, hot bricks, and the like should be applied to the body.

8. When the patient is able to swallow, warm fluids may be fed to him with a spoon. Stimulants to a moderate extent may also be given, and he should be encouraged to pass into a restful sleep.

The symptoms of drowning described are developed by suffocation, which the patient has fought as long as life held out, and more or less water has found its way into the lungs. In a few cases, the patient faints at once — the heart-beat and breathing stopping immediately, and the windpipe being closed by the epiglottis so that the water cannot pass through. Here the face of the patient is pale and flabby, and there is no frothy matter in the mouth and no water in the lungs. The treatment of both varieties is the same, but the prospect of recovery in this case is much better than the other.

The importance of emptying the water out of the lungs and stomach has always been recognized. It is accomplished with perfect ease by the method given here. *The plans of rolling upon a barrel or hanging up by the heels occasionally practised are barbarous and liable to cause harm rather than do good. They should* NEVER *be employed!*

The diaphragm or midriff is the chief factor in the methods of restoring the breathing. Satterthwaite's method is directed especially toward utilizing its function in breathing. In pressing toward the patient's back and head, he presses the diaphragm directly upward and pushes the air out through the windpipe. When he withdraws his pressure, the diaphragm returns to its ordinary position, and the air is sucked into the lungs to fill the increased space. When Sylvester's method is added to it, we have the breathing act still further imitated by the addition of the chest movements to those of the diaphragm. Artificial respiration, as performed by the combination of these methods, is the most perfect substitute for the natural breathing possible.

When the person has not been long in the water, it is often possible to restore breathing by irritating the nostrils with snuff, smelling salts, or ammonia, or tickling the throat with a feather, and rubbing the body briskly. But these methods are not to be relied upon, and too much delay in resorting to artificial respiration will endanger the life of the patient. Where there are several persons present to assist, one of these may apply these procedures in addition.

It is difficult to decide just how long a person can be under water

without dying. In some cases, it has been impossible to resuscitate persons after but a few minutes' submersion, while in others life has not been extinct after hours have been passed in the water. Hope, then, should not be abandoned even if an hour or two has elapsed since the patient sunk.

The time required for artificial respiration to restore the breathing is also very variable, some cases responding in a few moments, while with others it is a matter of hours. Efforts then should be employed with great persistence, and discontinued only after hours of faithful labor have demonstrated their uselessness.

Rescuing the Drowning. — Swimming is an art that is easily acquired with a little self-confidence, and when once learned is never forgotten. The main point for one to remember — who does not know how to swim, and who has accidentally fallen into the water, or who is learning to swim — is, that the human body will float if properly managed.

Even a very small article, such as an oar or a small board, will make it easy to keep the head above water, if the chin be rested upon it. And this can be done without any assistance.

It is possible, however, to float without any assistance. The secret of success is a willingness to sink on the back so that the face alone will be out of water. Throwing the arms out of the water or attempting to get the head and shoulders above the surface will cause the entire body to sink. But if a person lies back, with his hands above his head, and allows the water to arise nearly to his mouth and lips, he may float for an indefinite period.

The conduct of a bystander, in case of a drowning person, should vary according to his acquaintance with the art of swimming.

If none of the bystanders can swim, and the person has sunk within reaching distance, they should hold an oar, a fish-pole, or something of the kind to him, that he may grasp it as he arises, as almost invariably occurs at least once and often several times. If there is nothing else at hand, a coat should be taken off, and, holding it by one sleeve, the other or the skirts should be thrown to the unfortunate. Esmarch was told by an old sea-captain that he had saved many lives in that way.

When life-preservers are available, their use will occur to any one in the presence of a drowning person. But it should be remembered that anything that will float may be substituted for it, such as boards, boxes, logs, sticks of wood, etc. If one is not a good swimmer, he may throw a float of this kind to the drowning person, and then obtaining one himself, paddle by its aid to the one whom he is trying to save.

When one is a good swimmer, and the drowning person is at some distance, he should throw off as much clothing as possible and swim out to him, taking great care to avoid his clutch, for the death of a would-be rescuer has often resulted from being grasped at an inconvenient point, hampering him so that he could neither save himself or the one whom he hoped to rescue.

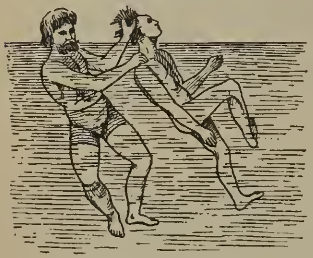

Fig. 136. — Grasping the drowning person.

1. Swim behind him and grasp him, preferably, by the hair — or if that be too short, by the collar — with the left hand, and with the right hand grasp his right shoulder; he can thus be kept harmless, with his face above water. Hold him at arm's length, and "tread water."

2. Watching the right arm of the drowning person until a favorable opportunity appears, seize it at the wrist, and draw it behind the head. Then prepare to swim to shore.

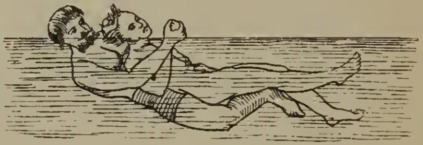

Fig. 137. — Controlling the right arm.

3. Having the right arm held behind his head, take a few strokes so as to float on the back and draw the drowning man on to the chest, gaining his confidence if possible, and swim toward the

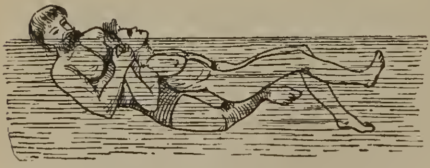

Fig. 138. — Drawing the drowning person on to the chest.

shore, not attempting to keep the head of either high above the water.

4. If the drowning person be unconscious, the work is made much easier, for he can then be drawn upon the chest without an effort either to avoid his clutch or to render him harmless.

Fig. 139. — Swimming to shore.

Breaking through the Ice. — A person who has become apparently drowned by breaking through the ice should be treated according to the methods prescribed for drowning in general.

To rescue such a person, it is not wise to attempt to walk out to him, for the ice may give way, and involve the would-be rescuer also. But if a person's weight is spread out upon the ice by creeping on all-fours, or, better still, by working his way flat on his abdomen, he may go where the ice would not bear the weight of a person erect. Or he may push a long board, a plank, or a pole out to the unfortunate, who may pull himself out upon it. Whoever attempts the rescue of a person who has broken through the ice, should attach to himself a long rope of some kind, with the other end made fast to the shore, for his own protection in case the ice gives way.

Smothering by Gases. — The gas which is particularly liable to affect life is carbonic acid. It is present in nearly every form of noxious vapor, whether in the so-called sewer-gas, the coal gas used for lighting houses, the choke-damp of the mines, the bad atmosphere of crowded rooms, vaults in which the fermentation of wine or beer is in process, or in the smoke of burning buildings.

Symptoms: The symptoms of smothering by gases are those of smothering in general — a swollen and purple face, livid lips, and bloodshot and staring eyes.

Treatment: In case a man is overcome by noxious gases, the main thing is to get him out into the open air. Rapidly loosen and, if possible, remove his clothing. Hold him in a half-sitting posture, with his head higher than his feet — just the opposite of the attitude advised for fainting. Rub the whole body briskly with flannel, or other fabric and restore the breathing by performing artificial respiration. From time to time dash moderate quantities of cold water over the body.

Caves and underground passages are liable to contain a greater or less quantity of carbonic acid gas. It is of frequent occurrence in mines, where it is known as "choke-damp," and in cellars containing fermenting beer or wine; it is found in sewers and drains intermingled with the sulphuretted hydrogen — which gives the offensive odor to rotten eggs — and still more noxious vapors. For this reason all unused underground places should be entered with caution. If a lighted candle burns all the way to the bottom, when let down into a pit, no dangerous amount of carbonic acid is present; still there may be other dangerous gases by which visitors may be overcome.

The first person to enter a pit or drain should carry tied to his person the end of a rope by which he can occasionally signal his safety to those remaining outside. Upon his failure to reply to any signals he should promptly be drawn out into the fresh air by the rope. Upon the discovery of noxious air in an excavation, it should be purified by violently agitating the air, by firing guns into it, by lowering and raising open umbrellas, by pouring water or quick-lime into it. When lowering a lighted candle, or firing a gun into a pit, precautions should be taken against injury by the possible explosion of inflammable gases.

If it be necessary to enter a poisoned shaft to rescue persons already insensible, the rescuer should have his nose and mouth covered with a cloth wet with vinegar, and, as previously stated, should be connected with the outer world by a signal rope.

If a room be filled with poisonous gas from any source, it is easily and rapidly cleared by opening the doors and windows from the outside. The victim should then be promptly carried out of the room and treated for smothering.

The gaseous products of fire are a frequent cause of death in burning buildings, and it is worth while to remember that in a room full of smoke from such a cause, the purer air is to be found near the floor. Hence it is often best to creep into a room in a burning house on the hands and knees. Moreover, the flames are an indication of oxygen, and air can be found to breathe wherever flames are seen.

They may burn one, but they indicate air to breathe. If these facts be known and remembered, many lives may be saved both of the occupants of burning buildings and of those who would save them.

Smothering by Pressure on the Chest. — This accident occurs when men are caught under falling earth or heavy debris, the face remaining uncovered. Other injuries which are liable to complicate the trouble add materially to the danger.

In this case, the victims should be dug out with as little delay as possible, and the suffocation should be treated by loosening the clothing, rubbing the body and dashing cold water upon it, and restoring the breathing by artificial respiration.

Smothering by Strangling or Hanging. — This injury is most frequently self-inflicted with suicidal intentions, although cases occasionally occur where men are caught by the straps of a harness or bridle and dragged about by the neck by a fractious horse, or are strangled in other accidental ways.

The most important point in the treatment of hanging is to *cut the person down*, and that with the least possible delay. When a person is seen hanging, it is homicidal to run to tell others of it before cutting him down, for in the minutes so occupied the victim may have passed completely to his death. So far as possible, support him with one arm, while cutting the rope with the other, so that he may not injure himself by falling too heavily to the ground. Then loosen the noose and treat him as for smothering from other causes. Quickly loosen, and if possible remove the clothing, keeping him in a half lying-down position, with the head higher than the feet. Rub the body briskly with flannel, towels, etc. Restore the breathing by practising artificial respiration, and dash cold water upon the body occasionally.

In all these cases a surgeon should be summoned immediately, the measures prescribed being resorted to while awaiting his arrival.

CHAPTER XXV

POISONS

Poisons. — *Definition:* A poison is any substance which taken into the system in small quantities will produce death or serious disorder.

Varieties: Poisons may be general, affecting the entire system, or local, affecting some particular part primarily, and the whole system only secondarily.

Symptoms: The symptoms of the various poisons differ according to the individual drug. But certain of them possess enough characteristics in common to enable them to be grouped and to render it easy to distinguish them. They are: —

1. Locally irritating poisons in which the symptoms are due entirely to the location of the poison.
2. General poisons, causing local irritation in which the poison affects the system at large in addition to producing local irritation.
3. Sleep-producing or narcotic poisons.
4. General poisons in which there is no local irritation.

Treatment: In the *first class* never cause vomiting. Give dilute acids to neutralize alkalies, and dilute alkalies to neutralize acids. Follow with soothing drinks of oil, raw eggs, and flour and water. Give opiates to quiet pain, and whiskey or brandy to relieve the weakness.

In the *second class*, except in case of arsenic, no emetic should be given, but the effect of the poison should be counteracted by bland doses of oil, flour and water, white of egg, and the like, while stimulating drinks should be given to counteract depression. The treatment of arsenic is peculiar to itself and should be studied individually in the tables.

In the *third class*, sleep-producing poisons, give an emetic; after producing repeated vomiting make the patient drink strong coffee and other stimulating drinks, and use every available means to keep him awake.

In the *fourth class*, general poisons, always give an emetic, follow with stimulating drinks to relieve weakness; give opiates to relieve pain, and put the patient to rest.

The individual poisons may best be considered in the form of a table, where they can moreover more quickly be found in an emergency.

1. Locally Irritating Poisons.

Poison.	Symptoms.	Treatment.
Acids: — Muriatic. Nitric (aqua fortis). Oxalic. Sulphuric (vitriol).	Excessively severe burning pain in the mouth, throat, and stomach. Difficult swallowing. Great depression. Extremities cold and clammy. Convulsions. (Death.)	*No emetic.* Alkali (baking soda, saleratus, magnesia, chalk, lime, plaster) — 3 or 4 teaspoonfuls in a glass of water. Drink soothing fluids, like oil. Stimulating drinks, if necessary. Opiates to relieve pain.
Acid, Carbolic: — Creosote.	Vomiting of frothy mucus. Lining membrane of mouth white, hardened, and benumbed. Severe pain in belly. Cold, clammy skin; insensibility. Snoring breathing. Odor of carbolic acid.	*No emetic.* White of eggs. Milk, or flour and water. Rest. Opiates.
Alkalies: — Ammonia (hartshorn). Lye. Pearlash. Potash, Caustic. Soda, Caustic.	Painful burning in mouth, throat, and stomach. Difficult swallowing. Bloody vomiting and purging. Great depression, etc., like acids.	*No emetic.* Dilute acids (vinegar or lemon juice). Soothing fluids, like oil, melted fat, thick cream, etc. Stimulating drinks. Opiates to relieve pain.
Silver: — Nitrate (Lunar caustic).	Same as above.	*No emetic.* Copious draughts of salt and water. Soothing drinks. Opiates.

2. Ceneral Poisons, causing Local Irritation.

Poison.	Symptoms.	Treatment.
Mercury:— Corrosive sublimate. Calomel. Vermilion.	Burning pain in throat, stomach, and bowels. Metallic taste. Vomiting and purging — frequently bloody. Increase of saliva. Sleepiness. Convulsions. Stupor.	*No emetic.* Raw eggs, milk, or flour and water. Castor oil. Stimulating drinks.
Arsenic:— Fowler's solution. Green coloring matter. Paris green. Rough on Rats. Scheele's green.	Burning pain in stomach and bowels. Tenderness of belly on pressure. Retching. Vomiting. Dryness of throat. Clammy sweat. Convulsions.	*Cause repeated vomiting.* Give hydrated oxide of iron made by adding 8 parts of ammonia water to 10 parts of solution of tersulphate of iron. Then castor oil. Rest, and stimulating drinks if needed.
Copper:— Verdegris. Blue vitriol. Food cooked in copper vessels.	Similar to those of arsenic. Coppery taste in mouth. Tongue dry. Colic. Bloody stools.	*No emetic.* White of eggs, if obtainable, — if not, flour and water. Ice. Opiates to relieve pain and excitement.
Iron:— Copperas. Green vitriol.	Burning pain in throat, stomach, and bowels. Colic. Vomiting. Purging. Cold skin. Weak pulse.	*No emetic.* Baking-soda in water. Then raw eggs and milk. Opiates for pain. Stimulating drinks for depression.

3. Sleep-producing or Narcotic Poisons.

Poison.	Symptoms.	Treatment.
Chloral: — A white, crystalline substance, with an acrid taste.	Profound sleep. Breathing slow and shallow. Pulse weak, rapid, and irregular. Remains of poison near by.	*Cause vomiting.* Stimulating drinks. Heat. Motion.
Opium: — Laudanum. Morphine. Paregoric. Sleeping mixtures in general.	Giddiness. Heaviness of the head. Sleepiness. Stupor. Pupils of eyes contracted to fine point. Signs of the poison near by.	*Cause vomiting.* Stimulating drinks — strong coffee. Keep up breathing. Warmth. Keep patient awake by whipping, if necessary. Motion.

4. General Poisons.

Poison.	Symptoms.	Treatment.
Aconite:— Wolfsbane. Monkshood.	Great depression. Extreme weakness. Cold sweat. Numbness of extremities. Weak and slow pulse.	*Cause vomiting.* Stimulating drinks.
Belladonna:— Atropia. Deadly nightshade.	Eyes very bright, and pupils enlarged. Dryness of throat. Paralysis of excretory organs. Delirium. Convulsions.	*Cause vomiting.* Opiates to relieve nervous excitement. Rest.
Lead:— Red lead. Sugar of lead. White lead.	Metallic taste in mouth. Cramps. Paralysis. Vomiting. Increase of saliva. Giddiness. Convulsions. Stupor.	*Cause vomiting.* Large doses of Epsom or Glauber's salts. Stimulating drinks.
Phosphorus:— Matches.	Pain in stomach and bowels. Vomiting. Purging. Signs of poison near by.	*Cause vomiting.* Magnesia in water. Soap suds. Rest. Warmth.
Prussic acid:— Cyanide of potash. Oil of bitter almonds. Laurel water.	Death may occur instantly in ordinary doses. In very small doses, giddiness, blindness, convulsions, fainting. Death may occur from smelling the odor only.	*No emetic.* Stimulating drinks (strong) without delay.
Strychnine:— Nux vomica.	Slight shuddering. Feeling of constriction of throat. Startings. Paleness. Intermittent jerkings. Convulsions. Ghastly grin.	*Cause vomiting* once or twice. Rest. Opiates. Chloral. Tannin.
Vegetable poisons:— Berries (Bitter-sweet, Deadly nightshade, Mountain ash, Poke, Potato). Hellebore, Hemlock, Horse chestnut, Indian tobacco, Jamestown weed, Wild lettuce, Wild parsley, Rhubarb leaves, Toadstools, Tobacco plant.	Nausea. Depression. Intoxication, Stupor, etc., varying somewhat with the poison.	*Cause vomiting.* Stimulating drinks. Rest.

Emetics. — In the majority of cases of general poisoning, the first step to be taken is to cause the patient to disgorge as much of the poison as possible by vomiting. Articles producing these acts are called "emetics."

1. Vomiting can be induced frequently by thrusting the finger back in the mouth to the pharynx; where another person's mouth is in question a feather, or some other soft object, may be used.

2. Drinking large quantities of warm water will often cause the desired effect. A little salt added to the water will increase the effect.

3. Chewing and swallowing tobacco in considerable quantities will cause the stomach to rebel. The tobacco itself in this case is poisonous, but by inducing vomiting it acts as its own antidote.

4. Drinking mustard or salt and water, made by adding a tablespoonful of common salt, or powdered mustard, to a tumblerful of lukewarm water, makes an excellent emetic.

Medical men will administer ipecac, apomorphine, sulphate of zinc, tartar emetic, and other drugs. But the readily available means of inducing vomiting here given should be employed while awaiting their arrival.

Weakness and shock following poisoning and its treatment should be treated by stimulation and warmth as already prescribed for those conditions.

Poison Ivy, Oak, Sumac. — Certain plants produce a painful rash when they merely touch the skin. In some cases the eruption has followed a near approach only to the plant, without direct contact, the poisonous effect being probably due to a noxious emanation from it. The more common of these plants belong to the rhus family, and are commonly known as the "poison ivy," or "poison vine," the "poison oak," and the "poison sumac."

The *poison ivy* or *poison vine* (*Rhus radicans*) is a climbing plant growing luxuriantly upon trees and rocks, and somewhat resembles the woodbine or Virginia creeper. But the poison ivy is three-leaved (Fig. 140), while the harmless variety is five-leaved. The poison ivy has a hairy

trunk and often has little white berries from the axils of the leaves.

The "*poison oak*" (*Rhus toxicodendron*) is an erect plant twelve to eighteen inches in height, with a leaf like that of the poison vine, consisting of three smaller leaflets (Fig. 140).

Fig. 140. — Leaf of the poison ivy or poison vine.

The "*poison sumac*" (*Rhus venenata*) is very similar to the ordinary sumac, except that, like the poison ivy, it has small, slender clusters of white berries growing from the axils of the leaves. In all other sumacs the berries are red and in close bunches at the ends of the branches, and these are not only harmless, but have an agreeable and wholesome acid taste.

Symptoms: A painful rash, sometimes uniformly red, and at other times consisting of collections of small elevations, surrounded by a greatly reddened surface. It is rather more frequent on the hands, face, and neck, but is often seen on and about the thighs. It may last from two or three days in mild cases to one or two weeks in the more severe.

Treatment: A very strong solution of bicarbonate of soda (*baking-soda*) will frequently check the trouble in the beginning. Any soothing ointment such as vaseline or petrolatum is also useful, and in the absence of these lathering the part with a soft shaving-brush will diminish the itching and burning.

Poisoned Wounds. — Certain poisons may be introduced directly into the circulation through wounds. Wounds may become poisoned in three ways: (1) By the development and multiplication of germs which induce death and decay of the tissues in an otherwise healthy wound. This variety of poisoned wounds has been fully discussed in connection with the germ theory, and rules have been given for its prevention

and treatment. (2) Wounds may become poisoned by the introduction of a poison after they have been inflicted. And (3) wounds may become poisoned by being inflicted with some poisoned instrument.

1. Poisons in common with most medicinal substances are readily absorbed through wounds with which they may come in contact. This is occasionally seen when, through the injudicious use of poisonous antiseptic agents in the treatment of wounds, or for other reasons, enough carbolic acid, corrosive sublimate, or iodoform has been absorbed to produce serious and even fatal poisoning. Wounds into which the poison has been introduced after the infliction of the injury should be treated, prior to the arrival of a surgeon, by removing the source of the poisoning and then employing the measures ordinarily applied to healthy wounds. Great care should be taken to avoid the introduction of poisons by the prompt application to wounds of clean dressings.

2. Wounds may be poisoned by being inflicted by some poisoned instrument, such as a poisoned arrow or dagger, or the teeth of an animal, the fangs of a reptile, or the sting of an insect. Poisoned weapons are rarely used at the present time even by savages.

If shallow, these wounds should be treated like bites of rabid animals; but if deep, such treatment would be of little avail, and ordinary wound treatment must suffice until the advice of a surgeon can be obtained.

Dog Bites, and wounds inflicted by the teeth of other animals, are usually simple wounds, unless the animal be mad. In this case the saliva of the animal contains a poison which is carried into the wound by the teeth, to pass into the circulation and produce a similar disease in man.

Treatment: Absolute safety to a person who has been bitten by a mad animal can only be secured by *immediately and entirely cutting or burning the wound out of the body*. While preparations are being made for doing this a bandage or handkerchief should be bound tightly about the limb — the Spanish windlass (page 151) is excellent for this purpose — above the wound, to

prevent the poison being carried into the circulation. The wound should be sucked to extract as much as possible of the poison, it being remembered that there is no danger from the poison being taken into the mouth, although it should be expectorated, not swallowed. Then with a sharp knife cut the bite out completely, or burn it out with a red-hot iron, or by filling it with powder and firing it. The patient should then be quietly laid to rest and given alcoholic drinks in large quantities to counteract the effects of shock.

Snake Bites. — This injury is most commonly due in this country to the rattlesnake, the copperhead, and the moccasin.

Symptoms: Following a bite, swelling and discoloration of the wound; headache, chills, and great weakness. If fatal, death may occur in from a few hours to several days.

Treatment: The bites of poisonous snakes may be treated in the same way as those of mad dogs. Suck the wound, — after having put a tourniquet about the limb above the bite, — taking care to expectorate the poison. Then cut or burn the bite and administer whiskey or other alcoholic drinks to the patient in large quantities.

Insect Stings. — Under this head are included the bite of the so-called tarantula, as well as the stings of the centipede and scorpion, the wasp, hornet, and bees.

The bite of the tarantula is sometimes fatal, and in Eastern countries the same result is said to follow the sting of the scorpion. But in this country the scorpion, as well as the centipede, does not produce fatal results, although the latter may inflict a painful and annoying injury. The bite of the tarantula and the stings of the centipede and scorpion should be treated in the same way as snake bites.

Insects in stinging usually leave their stings in the wound. It should first be extracted and the wound then treated with a solution of baking-soda. Clay made up into a paste with saliva is a favorite application which may be used in the absence of soda. The sting can usually be forced out by

pressing upon the skin by its side, or if a watch-key, or something with an open centre be pressed down upon it, the sting will be pressed out.

CHAPTER XXVI

DEATH

DEATH is the permanent cessation of all the functions which taken together constitute life.

1. The lungs cease drawing in and throwing out air — passing oxygen into the blood and extracting carbonic acid.

2. The heart ceases throwing the blood into the system and into the lungs.

3. The blood stops carrying its freight of oxygen into the tissues and its load of carbonic acid out of it.

4. The muscles cease acting and moving the body.

5. The nerves stop carrying telegraphic messages from the mind in the brain and spinal ganglia.

6. The viscera cease their digestive and excretory action.

7. Heat and motion depart.

8. The eyes become glazed and half open.

9. There is no feeling in the body.

10. The teeth are clenched, and froth often forms about the mouth.

11. The inciting power of all these actions, THE SOUL, departs, and —

12. The process of decay sets in.

When all these conditions have been fulfilled, death has occurred without a doubt, but in some cases the functions are carried on so imperceptibly as not to be readily perceived. Cases have occurred where, owing to a temporary diminution of these vital phenomena, death has been simulated so successfully that persons have been buried alive. This is, how-

ever, by no means as frequent as is often supposed, as is shown by the experience of certain foreign cities where provisions have been made for keeping bodies unburied until advancing decomposition places death beyond a doubt, surrounding them meanwhile with every appliance available for assisting resuscitation. Not a case is on record, however, of revival from trance or any other supposed counterfeit of death during all these years.

There are a number of more or less positive proofs of death: —

1. The breathing has stopped: there is no movement of the chest; the sound of the air passing in and out is absent, and there is no watery vapor proceeding from the mouth.

2. The heart has stopped: there is no pulse; the movements and sounds of the heart have ceased, and the veins do not become swollen upon making pressure between them and the heart.

3. The blood in the veins becomes clotted.

4. The red color in semi-transparent parts disappears.

5. The warmth of the body is replaced by coldness.

6. The muscles of the body relax at first and then become stiff usually in from five to six hours, remaining so for from sixteen to twenty-four hours.

7. There are no signs of rusting on a bright steel needle after plunging it deeply into the tissues.

8. Electricity has no effect upon the contraction of the muscles.

9. Decomposition of the tissues sets in, as is shown by the odor and the greenish blue discoloration, usually appearing first on the abdomen.

The fact of the breathing having stopped may be determined in two ways: (*a*) If the movements of the chest have absolutely ceased, there will be no movement in a glass of water, or better, a cup of quicksilver set upon the chest. (*b*) The absence of watery vapor proceeding from the mouth may be shown by holding a looking-glass or a bit of brightly polished metal, such as a razor-blade, over the mouth; if any breath proceeds from the lungs, it will be shown by the

collection of some drops of moisture upon the reflecting surface.

The cessation of the heart's action may be shown by tying a string rather tightly around a finger; if the person is living, the end of the finger will become reddened by the collection of blood beyond the string, and the removal of the string will leave a white line about the finger at that point.

When the body has become cold and, beyond all question, when decomposition has set in, death has occurred.

CHAPTER XXVII

THE EMERGENCIES OF THE BATTLE-FIELD

In no place is the demand for prompt attention to emergencies greater than on the battle-field. And with the progress of civilization, efforts to meet this demand have grown more systematic, until at the present time aid to the injured on the battle-field is rendered by thoroughly organized corps consisting of four classes: (1) Medical officers, (2) company bearers, (3) the hospital corps, and (4) civilian assistants, including female nurses, the various organizations for first aid to the injured, etc.

The medical officers comprise all those connected with an army, and include (1) the surgeons and assistant-surgeons attached to regiments, and (2) the medical officers of the general staff, who administer the field — and permanent hospitals, etc.

The company bearers are certain privates of the line, who, in addition to their military duties, are instructed in first aid to the injured and in the transport of the disabled. These men are not detached from their companies, and being present in the line of battle, naturally bear the main burden of the immediate aid to the wounded. They must therefore be well drilled in rapid extemporaneous wound treatment.

In the United States Army four company bearers are appointed in each company, this number being chosen in order to give to each unit of the military organization a complete litter squad. Each company is provided with a litter for the use of this squad. The bearers wear a brassard of red cloth on the left arm, above the elbow, as a designating mark. The company bearers are expected to be selected with a view to their suitability for future transfer to the hospital corps.

The hospital corps is a distinct organization, consisting of men whose duties are limited entirely to sanitary work, and is consequently of much greater importance in the care of the sick and wounded. Its members are selected because of their conspicuous adaptability to the peculiar duties of the corps. They must be brave and active, strong and gentle, and possessed of presence of mind and inventive faculty sufficient to meet the varying emergencies of succor to the injured.

The uniform of the hospital corps is similar to that of other enlisted men, except that the trousers are of dark blue cloth, bearing an emerald-green stripe piped with white, down the outer seam of each leg. They wear a white brassard bearing a red cross on the left arm, above the elbow (Figs. 147 and 148), and the cap or helmet ornament is a white metal Geneva cross.

The non-commissioned officers are known as hospital stewards, and they wear a sergeant's chevron of emerald-green piped with white, and having an arc of one similar bar across the top, the whole enclosing a red cross, and are armed with a straight sword.

Certain privates of the corps are also detailed as acting hospital stewards, and are then practically non-commissioned officers, having an increase of pay and wearing chevrons like those of the hospital steward, omitting the arc: they also wear a straight sword.

In case of active hostilities, the hospital corps is present with the troops in the proportion of two per cent of the aggregate strength of the command — a proportion which experience has shown to best supply the needs of the removal and care of the injured. To every ten privates of the hospital

corps there should be an acting hospital steward, and to every thirty privates there should be a hospital steward.

The privates of the hospital corps are organized into a company for each brigade, with their hospital stewards and acting hospital stewards under the command of an officer of the ambulance service, or a medical officer detailed for that purpose, and habitually camp near the division hospital, or, if there be none, the brigade or field hospital.

To them is committed the exclusive care of the sick and wounded after they are brought to the first dressing-stations, and except by special assignment of competent military authority no others are permitted to take or accompany sick men to the rear, either on the march or upon the field of battle. They perform all the duties connected with their corps at various points, under the direction of their officers, and after an action or upon the completion of any special duty, they rendezvous at the camp near the division hospital.

The non-commissioned officers are mounted in the field, and all the men are mounted when serving with mounted commands. A mounted private of the hospital corps, carrying a medicine case and such instruments and dressings as may be considered necessary, accompanies every medical officer into the field.

The equipment of the hospital corps in the field consists of a canteen of water, a hospital corps knife, and one or more first aid dressing-packets. In addition to this, every fourth hospital private carries a hospital knapsack or dressing-case containing the requisites for prompt aid to the injured, and first dressings.[1]

[1] In connection with the National Guard and State Forces it is often impracticable to organize a distinct hospital corps, and in this case the company bearers may be utilized in the formation of a corps, which may not only form the nucleus of a hospital corps in case of active hostilities, but also provide for the safety of the community a body of men well instructed in meeting ordinary medical emergencies. This should be formed by the detail of four men from each company, of whom a proper proportion should be non-commissioned officers.

For a regiment of ten companies the sanitary corps should be formed (1) from the regimental staff by the Surgeon, the Assistant-Surgeon, and the Hospital Steward, who will act in the capacity of first sergeant; (2) from the companies, by one sergeant, four corporals, and thirty-five privates.

The work of the hospital corps in the field is attended with some immunity by the provisions of the Articles of the Geneva Convention which have been adopted by nearly all civilized nations. The articles provide for the neutrality of field and permanent hospitals, of all their attendants, and of members of the hospital corps, — not of company bearers, — and permit the staff of hospitals to continue their labors after the occupation of the country by an enemy, or to pass unmolested to their own commands. The sick are protected, those caring for them are rewarded by protection, and wounded prisoners, when cured, are returned to their own country on parole. A flag having a red cross on a white field insures the safety of hospitals, while a white brassard on the left arm, also bearing a red cross, protects the members of the sanitary corps.

During an engagement, and until relieved by the hospital corps detachment, the company bearers render first aid to the injured *on the line of battle*, under the supervision of the medical officers on duty at that point. Here the medical officers and company bearers, with the detail of the hospital corps, when it shall have arrived at that point, take measures to prevent immediate danger from wounds, not, however, attempting any operations. Those cases which demand immediate operative action are to be designated by a colored badge which is attached to their clothing by the first medical officer into whose hands they may come. These will receive the first attention at the dressing-station.

Immediate danger having been temporarily forestalled by the attention given on the line of battle, the bearers — of the hospital corps, or of the company, if the former have not arrived, or both, if the demand is too great to be satisfied by the hospital corps alone — place the wounded upon litters, if

For a regiment of twelve companies, the sanitary corps should be formed (1) from the regimental staff by the Surgeon, the Assistant-Surgeons, and the Hospital Steward, who will act in the capacity of first sergeant; (2) from the companies, by two sergeants, four corporals, and forty-two privates.

Such an organization, when properly instructed in anatomy and physiology, in aid in medical and surgical emergencies, and in the carriage of the disabled, will form a very satisfactory peace substitute for a hospital corps.

they are unable to walk, and carry them back to the next point. If the injured are able to walk alone or with the assistance of a single helper, they are not carried.

Fig. 141. — The work of the first line.

The next point of relief, as well as all the remaining points, is to be located by the medical director of the army corps, or the senior medical officer present. It is *the first dressing-station*, and is situated as near the line of battle as possible, consistent with safety. When the troops are fighting behind fortified works, it may be on the line of battle itself. In any case no attempt is made to place it beyond the range of artillery fire, but it should be so placed as not to be affected by ordinary rifle fire, and in as sheltered a spot as possible. To this point are brought or sent all wounded men. Here are performed all urgent operations, and here the wounded are prepared for conveyance to the field hospitals.

The importance of this station is recognized by the surgeons of the present day, among whom the character of the first dressing is considered to be of paramount importance. Whence the necessity of surgical assistance at this point, ample both in amount and in skill, will be evident.

The first dressing-station is established early during the

engagement by men of the hospital corps under the direction of the medical officers, care being taken not to locate it at a point where it will be in the way of the manœuvres of the combatants. This having been done, the men provide water and straw, prepare the dressings, and when required assist in the removal of the wounded. This is the point beyond which the company bearers cannot pass. After depositing their charges they are required to return to the front. When the line of battle is of considerable length and large bodies of troops are engaged, there are a number of these stations, varying according to the necessities of the case, certainly not less than one to each brigade.

The wounded having received proper immediate treatment, they are now to be transported to the field hospitals. At a point as near the first dressing-station as possible the ambulances rendezvous for this purpose. This point is the *ambulance station*, and the injured are borne to this point upon hand-litters. Where the character of the country is such as to permit it, the ambulances may be driven directly to the first dressing-station, thus obviating the necessity of having a separate station. In removing a man, care is taken to send with him his arms and accoutrements, always seeing that his piece is discharged before placing it in the ambulance. At the ambulance station tents are pitched and arrangements made for the temporary accommodation of the wounded as they are brought in from the first dressing-stations. Attendants are at hand with hot drinks and other means of relieving suffering. Medical officers are present to inspect the patients and make it sure that they are in a suitable condition to be forwarded; dressings are altered if necessary, and other attentions, the need of which may have been overlooked at the first dressing-station, are given.

The three points now enumerated all lie near the line of battle, and are all included in the phrase *the first line of medical assistance.* The combination is also known as the *service of the front.*

An important part of the duty of the hospital corps stationed at the *front* is the careful examination of the field after an

Fig. 142. — SEARCHING FOR THE WOUNDED WITH THE AID OF THE ELECTRIC SEARCH-LIGHT.

engagement, to see if any wounded men remain uncared for, or to ascertain if any men supposed to be dead still show signs of life. If there is simply a cessation of hostilities due to the nightfall, the search is greatly facilitated by the use of the electric search-light (Fig. 142), and where one is not present, lanterns must be used.

The fourth point is the *field hospital* or division hospital, still further to the rear. The field hospitals form *the second line of medical assistance*. They are located by the medical director at points decided upon in consultation with the commanding general. A field hospital should be two or three miles to the rear of the dressing-stations, and should be more permanently organized. The duties of the hospital corps here are multifarious, and consist in arranging the beds for the wounded, assisting the surgeons in operating and in applying dressings, administering stimulants to this man, and sedatives to that one, caring for the belongings of the patients, and maintaining order in the hospital — meeting all the innumerable emergencies which necessarily arise at such a time. The hospital steward in charge of the stores will have established his kitchen at a suitable point, and his cooks will be engaged in preparing not only the necessaries for the sick, but the food for the attendants. The hospital steward in charge of the medicine wagon will have abundant occupation in putting up such medicines as may be demanded, while those to whom is assigned the care of instruments and dressings will have no time to spare. A guard is mounted and the hospital property patrolled to prevent injury to its occupants or loss of property.

The field hospitals are necessarily temporary in character, and the sick and wounded require more permanent quarters for their ultimate treatment. These are found in *the third line of medical assistance*, which consists of the stationary hospitals in the extreme rear, and includes the general hospitals located in the vicinity of the base of operations, and still farther to the rear, and includes hospital boats and hospital railway trains. The nursing and attendance at these points, as at others, falls upon the hospital corps with the assistance of volunteer male and female nurses.

In this way is provided a complete system of treatment for the sick and wounded, covering the entire period from their fall upon the battle-field to their recovery and discharge from the general hospital.

CHAPTER XXVIII

CARRYING THE DISABLED

In carrying the disabled for short distances, a manufactured litter is to be used where practicable, consisting essentially of a bed long enough and wide enough to hold a man lying upon his back, and having along either side a pole projecting at each end for handles.

The authorized litter of the United States Army consists of two poles of seasoned white ash, seven feet eight inches long and an inch and a half square, the ends rounded off for handles. The poles are connected two feet from each end by wrought iron braces twenty-three inches in length and three-quarters of an inch in diameter, hinged in the middle by a clamp joint. The legs consist of wrought iron straps an inch and a half wide, bent into a suitable shape with rounded corners, each leg fixed eighteen inches from the ends of the handles. A canvas bed, six feet long, is tacked on the poles at equal distances from the ends, so as to be tightly stretched when the cross-braces are extended. This litter is used both as an ambulance litter and as a hand litter. In the latter case, its carriage is assisted by two slings of strong webbing with a loop at one end, and at the other a strap and buckle, by which its length can be adjusted: the sling is a part of the equipment of the bearer, and not of the litter. The question as to whether the litter shall have sliding handles or not has not yet been fully decided. The Halstead litter — an excellent form similar to the above, but with folding legs — is, however, still used at all army posts, and is shown in most of our illustrations. The Otis litter is similar in plan to the Halstead, but has sliding handles and shorter folding legs, being designed for use in the Otis ambulance, the ambulance still in use in the army.

To the injured man the slightest movement may be pregnant with excruciating agony. The least jar is productive of actual torture. A mere touch may cause him to shriek with pain. The chief aim, then, in carrying him is to move with

such gentleness and care as to render the motion as nearly imperceptible as possible and certainly free from any jar. In order to accomplish this, there must be a perfect understanding among the several bearers, as to the course to be taken and the method to be adopted, and all must unite in performing the movements in perfect unison. A well-defined uniform system of manipulating the injured, which may be perfectly understood by all participating in the movements, is then a prime requisite for success. The system of the United States Army[1] is the result of a long series of experiments and careful comparison of the work of others during several years of study by the entire medical and hospital corps, and is the best yet devised. We have been kindly permitted to reprint this system, with the addition only of explanatory illustrations, and designating by the smaller type those portions not necessary for the civilian bearer.

THE DETACHMENT.

1. The detachment is formed in single rank, privates of the Hospital Corps on the right, company bearers on the left, each class graduated in size, the tallest men on the right.

2. The senior hospital steward is on the right of the line; the junior and acting hospital stewards are in the line of file-closers in order of seniority from right to left. The file-closers are posted two yards in rear of the line, and are equally distributed along it. If the detachment is large, the second steward may be placed on the left of the line as guide.

TO FORM THE DETACHMENT.

3. The steward, facing the detachment and six yards in front of its centre, commands:

FALL IN;

at which the men form in single rank, facing to the right.

[1] *The Manual of Drill for the Use of the Hospital Corps, U. S. Army.* Published by authority of the Secretary of War. Washington, Government Printing Office, 1891.

4. The steward having sized the men, and having seen that the file-closers are in their proper positions, commands:

Left, FACE;

and calls the roll.

He then commands:

Count, FOURS;

and, facing to the front, salutes the officer in charge, who is in position at a suitable distance in front of the centre of the line, reports the result of the roll-call, and then takes his place on the right of the detachment.

5. The steward having saluted, the junior officers take posts, assistant surgeons in the line of file-closers, and surgeons four paces in rear; they distribute themselves equally along the line, in order of seniority from right to left.

The officer then commands:

Right, DRESS; FRONT.

TO MOVE THE DETACHMENT.

6. The detachment having been thus formed may be moved in line or in column of files, of twos or of fours, as follows:

IN LINE.

To march forward, by the commands: (1) *Forward*, (2) *Guide right* (or *left*), (3) MARCH.

To march backward from a halt: (1) *Backward*, (2) *Guide right* (or *left*), (3) MARCH.

To side step at a halt: (1) *Side step to the right* (or *left*), (2) MARCH, (3) *Detachment*, (4) HALT.

To pass from quick to double time: (1) *Double time*, (2) MARCH; to resume the quick time: (1) *Quick time*, (2) MARCH.

To change direction during a forward march: (1) *Right* (or *left*) *wheel*, (2) MARCH, and when the desired front has been obtained, (3) *Forward*, (4) MARCH, or if the intended change of direction be slight, the command is: *Incline to the right* (or *left*).

IN COLUMN OF FILES.

The detachment being in line at a halt, the column is formed and then moved by the commands: (1) *Right* (or *left*), (2) FACE, (3) *Forward*, (4) MARCH.

If in march, the commands are: (1) *By the right* (or *left*) *flank*, (2) MARCH.

To change direction in march: (1) *Column right* (or *left*, or *half right* or *left*), (2) MARCH.

To form line when marching: (1) *By the right* (or *left*) *flank*, (2) MARCH, (3) *Guide right* (or *left*).

To halt and form line: (1) *Detachment*, (2) HALT, (3) *Left* (or *right*), (4) FACE.

Or line may be formed from the column of files by the commands: (1) *Left* (or *right*) *front into line*, (2) MARCH, (3) *Detachment*, (4) HALT, (5) *Left* (or *right*), (6) DRESS, (7) FRONT.

IN COLUMN OF TWOS OR FOURS.

The column is formed and moved by the commands: (1) *Twos* (or *fours*) *right* (or *left*), (2) MARCH.

This column changes direction by the commands given above for the column of files.

To change into line: (1) *Twos* (or *fours*) *left* (or *right*), (2) MARCH, (3) *Detachment*, (4) HALT, (5) *Right* (or *left*), (6) DRESS, (7) FRONT; or line may be formed as from the column of files by the commands: (1) *Right* (or *left*) *front into line*, (2) MARCH, etc.

Or, the column of fours at single rank distance as formed above may be closed to double rank distance: (1) *Double rank distance*, (2) *Double time*, (3) MARCH; and the column thus formed having been marched as required may be spaced to single rank distance by the commands: (1) *Form single rank*, (2) MARCH; after which it is brought into line by: (1) *Fours left* (or *right*), (2) MARCH, (3) *Detachment*, (4) HALT, (5) *Right* (or *left*), (6) DRESS, (7) FRONT.

To form column of twos from column of files the commands are: (1) *Form twos*, (2) *Left* (or *right*) *oblique*, (3) MARCH; and the column of twos is reformed into column of files by: (1) *Right* (or *left*) *by file*, (2) MARCH.

7. *To rest the detachment* in any of its formations:

1. *Detachment*, 2. REST.

8. *To resume attention:*

1. *Detachment*, 2. ATTENTION.

9. *To dismiss the detachment:* The officer directs the steward: *Dismiss the detachment*, when the junior officers fall out and the steward commands:

1. *Break ranks*, 2. MARCH.

Inspection.

10. The detachment being in line at a halt, the steward, drawing sword, salutes the surgeon in command, reports and takes his place on the right.

The surgeon then draws sword, and, upon the approach of the inspector, the surgeon commands:

Detachment, ATTENTION;

and salutes the inspector, who acknowledges the salute and directs: *Prepare your detachment for inspection.* The surgeon then commands:

Rear open order, MARCH, FRONT.

11. At the first command, the steward steps briskly three paces to the rear to mark the new alignment of the file-closers, and the surgeon places himself three paces in front of the right file facing to the left. At MARCH, the junior officers step forward, each by the nearest flank, and place themselves opposite their places in line, three paces in front of the detachment; the men in rank dress to the right; the file-closers step backward and align themselves on the steward. The surgeon superintends the alignment of the junior officers and the rank, and the steward that of the file-closers; the surgeon then verifies the alignment of the file-closers; the junior officers and file-closers cast their eyes to the front as soon as their alignment is verified. At FRONT, the steward resumes his place in rank, and the men cast their eyes to the front.

From his position on the right of the line of officers and facing to the left, the surgeon commands:

Draw, KNIFE.

12. At *draw*, each man provided with a knife grasps and slightly raises the sheath with the left hand and seizes the grip with the right, thumb to the rear and against the guard; at KNIFE, he draws the hand quickly and raises the arm to its full extent, at an angle of about forty-five degrees, the knife in a straight line with the arm, then drops the arm naturally extended by the side, back of blade to the front, point down. Simultaneously the junior and acting stewards draw sword, and bring it to a carry.

13. He then commands:

Inspection, ARMS,

and faces to the front. As soon as inspected he returns sword, and accompanies the inspector. When the latter begins to inspect the line, the junior officers face about and stand in place rest.

Commencing on the right, the inspector now proceeds to minutely inspect the sword or knife, accoutrements, and dress of each soldier in succession. Each man, as the inspector approaches him, brings his sword or knife vertically to the front, raising the hand as high as the neck and six inches in front of it, edge to the left, the thumb on the back of the grip; after a slight pause, he turns the wrist outward to show the other side of the blade, then turns the wrist back, and as the inspector passes on resumes the original position; after the inspector has passed he returns sword or knife without command.

Fig. 143. — Inspection, arms.

14. *To return knife*, each man grasps the sheath with the left hand, quickly raises up the right hand as high as the neck and six inches in front of it [as for inspection], then drops the point of the knife and sheathes the blade.

15. This inspection completed, the surgeon again takes his post on the right, and commands:

Inspection, CASES,

and facing to the front, returns sword, and accompanies the inspector as before. At CASES, the men make a half-face to the right; those bearing dressing or medicine cases shift them to the front, the others take their dressing packets in the right hand, and all face again to the front; as the inspector passes, the cases are opened so as to expose their contents, and the packets are shown.

After the inspector has passed, each man makes a half-face to the right, closes and replaces the case or returns the packet, and faces to the front.

16. If the members of the Hospital Corps are equipped with blanket-bags, the acting stewards so equipped then place themselves on the left of the rank; the surgeon, from his post as before, commands:

1. *Unsling*, 2. BLANKET-BAG; 3. *Open*, 4. BLANKET-BAG.

At the first command, each man makes a half-face to the right, and unfastens the hook of the right strap by seizing the D ring with the thumb and forefinger of the left hand passed under the blanket-bag; he then unhooks the strap with the right hand, and unslings the blanket-bag by passing the right forearm over the head; at the same time he faces to the front, and, standing erect, holds it by the strap in front of the knees. At the second command, he places the blanket-bag on the

ground against his toes, the straps underneath, the great coat outward, and then stands at attention. At the fourth command, he opens the blanket-bag, turning the flap from him, the flap resting on the great-coat; he then stands at attention.

The blanket-bag having been inspected, the surgeon commands:

1. *Repack*, 2. BLANKET-BAGS.

At the second command, each man repacks and fastens up his blanket-bag, leaving it in the same position as before opening it, and then stands at attention. He then commands:

1. *Sling*, 2. BLANKET-BAGS.

At the command *Sling*, each man grasps the unhooked (right) strap with the right hand, the hooked left strap with the left hand, the back of the left hand to the right, raises the blanket-bag, and, standing erect, makes a half-face to the right. At the second command, he swings the blanket-bag over his shoulders, passing the left arm through the hooked strap, and carrying the right-hand strap over the head. He then brings this strap down over the right shoulder, makes a half-face to the left, and hooks the strap with the right hand, holding the D ring with the thumb and forefinger of the left hand, passed under the blanket-bag.

The acting stewards resume their places in line, and each man stands at attention.

17. The inspection being completed, the surgeon commands:

Close order, MARCH.

At MARCH, the file-closers close to two paces and the junior officers resume their places in line.

18. If there is no junior officer and the detachment is small, the ranks need not be opened, the junior or acting steward, if present, being placed on the right or left of the rank.

19. In case any of the members of the detachment are mounted men, their horses and horse equipments will be examined after the inspection of the men dismounted.

MUSTER.

20. All stated musters of the detachment are, when practicable, preceded by a minute and careful inspection.

The detachment being in line with ranks open, the non-commissioned staff officers (if any) place themselves in the line of file-closers, on the left of the stewards, with swords at a carry. The surgeon, upon intimation of the mustering officer, commands:

Draw, KNIFE; *Attention to muster.*

He then returns sword, and hands a roll of the Hospital Corps detachment and non-commissioned staff to the mustering officer. The latter calls over the names on the roll; each man, as his name is called, answers "Here," and returns sword or knife. Men without sword or knife are placed on the left, and, after answering, step forward one pace. The muster completed, the ranks are closed and the detachment is dismissed.

21. After muster, the presence of the men reported in the hospital or on other duty is verified by the mustering officer, who is accompanied by the surgeon.

LITTER DRILL.

22. For the purposes of litter drill each set of four is a litter squad. The squads are numbered numerically from right to left: if there is an incomplete set, its members are directed to fall out as dummy wounded or for special duty as may be required.

23. No. 1 is chief of squad; No. 4 carries the dressing case.

24. The officer in command will make such changes in the personnel of the sets of four as he deems advisable. The selection of No. 1 should be determined by the intelligence and experience of the men; No. 4 should be as near in size as possible to No. 1, and No. 2 to No. 3. The fours are then counted again, if necessary. The men having once been placed in this manner should always fall in thereafter in their assigned places.

25. The officer then commands:

Count, SQUADS,

when each chief calls out the number of his squad, in numerical order from right to left.

26. Having assigned the medical officers and stewards to appropriate duties, he commands:

Procure litter, MARCH,

when No. 3 of each squad steps one pace to the front, faces as required, proceeds by the nearest route to the litters, takes one, and, returning with it on the right shoulder at a slope of at least forty-five degrees, canvas down, resumes his place by

passing through his interval a yard to the rear, facing about, and stepping into line.

In procuring, as well as in returning the litters, the men follow each other in the numerical order of their squads.

He may then form the line into column of twos or fours for marching, or may proceed with the instruction of the squads in litter drill.

DRILL WITH THE CLOSED LITTER.

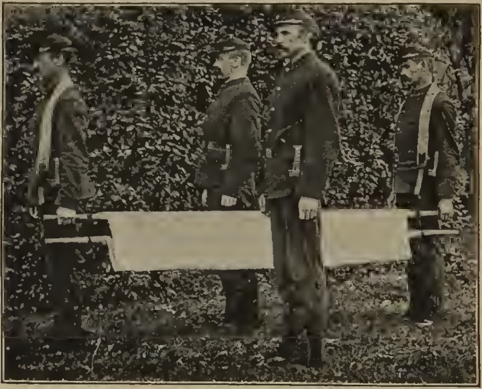

Fig. 144. — Carry, litter.[1]

27. To *carry litter* from position in line, the order is given:

Carry, LITTER,

when No. 3 places his left hand upon the litter at the level of the shoulder, and pressing the lower handles backward, with the right hand brings the upper handles forward and

[1] In this cut the litter handles have been fastened together, making it possible to carry the litter by the upper ones only. Ordinarily, the bearers (as stated in par. 34) grasp the lower handles, which support the upper ones and do away with the necessity for having them fastened together.

downward until the litter is in a horizontal position, canvas to the left; meanwhile the other numbers step directly to the front, No. 2 until he is opposite the front handles, which he seizes with his left hand, and Nos. 1 and 4 until they are opposite the centre of the litter.

28. The line of litters may be manœuvred by the commands already given [par. 6] to *march forward* or *backward*, to *side step at a halt*, to *pass from quick to double time* or the reverse, and *to change direction during a march.*

29. *To march to the rear*, a movement which may be occasionally required, the commands are:

To the rear, MARCH,

when all the members execute an *about*, No. 2 left, the others right, the two bearers meanwhile transferring the handles from one hand to the other. On halting, the members face about to the front without command.

30. At a halt, the line of litters *wheels* on the front bearer of the right (or left) squad as a fixed pivot.

31. In changing direction during a forward march, the line wheels on the right or left squad as a movable pivot until the desired direction is obtained.

32. A single squad, apart from others, is *faced* as a unit, as follows:

Litter right (or *left*), FACE,

when No. 2 steps off to the right and No. 3 to the left, both describing a quarter of a circle, so as to make the litter revolve horizontally on its centre until both face to the right — Nos. 1 and 4 maintain their relative positions opposite the centre of the litter.

33. In marching the line by its flank it is converted into a column of litters (single), but this cannot be effected by the commands applicable to men without litters, or with litters at a shoulder, because the front occupied by the squad does not give enough of space to enable each litter to face — a greater interval between the squads is needful.

To face the squads of a detachment so as to march them in column of litters or to increase the intervals between the squads for purposes of drill or service, the commands are:

1. *By the right* (or *left*) *flank*, 2. *Take one yard* (or more) *intervals*, 3. MARCH.

At the second command the first litter faces to the right on a movable centre, so as to gain sufficient ground; and at MARCH, advances in the

new direction, each succeeding litter facing in the same manner as soon as its flank is clear, and following one yard (or more) in rear of the squad on its right until the last squad has obtained its interval, when the instructor continues the march or halts the command and forms line, as may be desired.

34. If a line is to be formed the commands are:

Detachment, HALT; *Left* (or *right*), FACE; or
By the left (or *right*) *flank*, MARCH; *Detachment*, HALT.

35. The litters being shouldered (par. 47) and rank formed, the squads may be closed again by the commands:

1. *By the right* (or *left*) *flank*, 2. *Close intervals*, 3. MARCH,

when the right squad standing fast, the other squads face to the right, close up and successively halt, and face to the front.

36. The line of litters, at close or open intervals, may be formed in column of twos, by the commands:

Litters, *Twos right* (or *left*), MARCH,

each two wheeling on the front bearer of the right (or left) squad as a pivot.

37. The column may be formed and march to the front by the commands:

Right (or *left*) *forward*: *Twos right* (or *left*), MARCH.

38. The line formation is recovered by:

Litters, *Twos left* (or *right*), MARCH, *Litters*, HALT, *Right* (or *left*), DRESS, FRONT.

39. Or by:

Left (or *right*) *front into line*, MARCH, *Litters*, HALT, *Right* (or *left*), DRESS, FRONT.

40. An *about* with the litters at open intervals or in single column is executed by the commands:

Litters, *About*, FACE,

when Nos. 2 and 3 step off as in facing to the right (par. 32), but continue the movement until both face to the rear, the other numbers maintaining their relative positions opposite the centre of the litter.

41. *To change bearers* the commands are given:

Change Posts, MARCH,

when No. 1 takes position as No. 3, and No. 4 as No. 2, while Nos. 3 and 2 step to the left and right, respectively, into the vacated positions; the change is effected without halting, if in march.

42. The chief of squad continues to exercise command from whatever position he may occupy.

43. When the bearers are again changed the members of the squad resume the positions as at Carry Litter (par. 27).

44. To *ground the litter from the position of carry*, the order is given:

Ground, LITTER,

when Nos. 2 and 3 lower it to the ground, lengthwise between the files, canvas up.

Fig. 145. — Ground, litter.

45. Posts at the grounded litter may at any time be recovered by the commands:

At litter, POSTS,

when the numbers take posts, No. 2 on the right of the front handles, No. 3 on the left of the rear handles and close to them, and Nos. 1 and 4 respectively on the right and left of the litter at its midlength and one pace from it, all facing to the front. This is the invariable position taken by each number at the above commands, whatever may have been his previous position or duty.

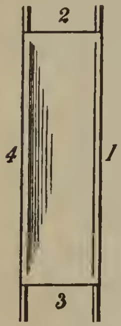

Fig. 146. — Diagram, showing the position of the bearers at litter posts.

46. *To carry litter when grounded:* At the commands:

Carry, LITTER,

Nos. 2 and 3 grasp the litter and raise it from the ground to the position of *carry*.

47. *To shoulder litter from the position of carry:* At the commands:

Shoulder, LITTER,

No. 2 raises his end to assist No. 3, who places the litter on his right shoulder, canvas down, supporting it at an angle of 45 degrees by the right arm and hand; meanwhile the other numbers step backward and align themselves upon him in regular order.

48. *To bring the litter to an order from a shoulder:* At the commands:

Order, LITTER,

No. 3 brings it to a vertical position and drops the lower handles to the ground, supporting it by the right hand at the level of the shoulder (Fig. 148).

Fig. 147. — Shoulder, litter. The Otis litter was used here.

49. *To shoulder litter from the position of order:* At the commands:

Shoulder, LITTER,

No. 3 grasps the litter with both hands well below its middle, fingers to the front, and raises it to the shoulder.

50. In the field the litter should always be carried closed and only opened on reaching the patient.

51. *To open the litter:* At the commands:

Open, LITTER,

the strapped litter, if at a carry, is first lowered to the ground, when Nos. 2 and 3 unbuckle the straps and fasten the free end of each to the pole, then grasp the ends of the right pole with their right hands and rise. This leaves the litter suspended longitudinally, canvas to the left. They then extend the braces, and supporting the litter horizontally by both poles lower it to the ground and resume the position of attention, each between the handles of his end of the litter.

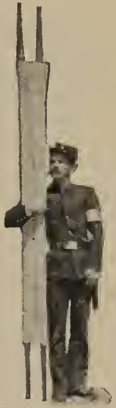

Fig. 148. — Order, litter.[1]

52. This is the position of the squad when at *litter posts* with the open litter.

53. If the litter be merely folded (that is, unstrapped), it is first brought to a carry, if on the ground (par. 46), when Nos. 2 and 3 drop the left pole, extend the braces, lower the litter, and take position as before.

54. To *close the litter*, the commands are given:

Close, LITTER,

when Nos. 2 and 3 side-step around the handle to the right and left, respectively, face inwards, stoop, and with their right hands raise the litter by the right pole. They then fold the braces and support the closed litter with the hand grasping the lower handles when they face to the front.

[1] In this cut, the canvas has been folded about the litter, so that the bottom does not show, as in Fig. 147, where it has simply been folded upon the top to form a cushion for the shoulder.

55. The litter is strapped by Nos. 2 and 3 at the termination of the exercises.

56. The detachment being in line at a halt, with the litter at a shoulder, at the commands:

Return litter, MARCH,

No. 3 steps one pace to the front, faces as required, and proceeds by the nearest route to the place designated for the litters, where he leaves it, and, returning, resumes his position in line.

DRILL WITH THE OPEN OR LOADED LITTER.

57. *To lift the litter.*—The squad being in position with the men at *litter posts* (par. 52), the commands are given:

Prepare to lift, LIFT.

At the first command Nos. 2 and 3 slip the loops of their slings over the handles, beginning with the left, and grasp the handles; at the second command they rise slowly erect.

58. At the order:

Forward, MARCH,

the bearers step off, No. 2 with the left, No. 3 with the right foot, taking short sliding steps of about 20 inches, to avoid jolting and to secure a uniform motion of the litter. Nos. 1 and 4 step off with the left foot.

59. The so-called single step, which is by far the easiest for the patient, but which is acquired with difficulty, may also be practised. No. 2 steps off with the left foot and No. 3 follows with his right an instant later and before No. 2 has planted his right; No. 2's right foot next touches the ground, and is immediately followed by No. 3's left.

60. *To lower the litter*, the order is given:

Lower, LITTER,

when Nos. 2 and 3 slowly lower the litter to the ground, release the slings from the handles, and stand erect.

61. The open litter should be lifted and lowered slowly and without jerk, both ends simultaneously, the rear bearer moving in accord with the front bearer, so as to maintain the canvas horizontal; in fact the open litter should be handled for purposes of drill as if it were a loaded litter.

62. For drill with the loaded litter dummy patients are directed to lie down wherever required, and each squad is separately exercised in loading, marching, passing obstacles, unloading, etc., under the orders of its chief or an instructor.

63. *To cease drilling and reform the detachment*, the officer in command directs the first squad to resume its original position in line with loaded litter, whereupon the other squads at once proceed, in numerical order, to their places in line with loaded litter; the patients are then directed to rise and fall out.

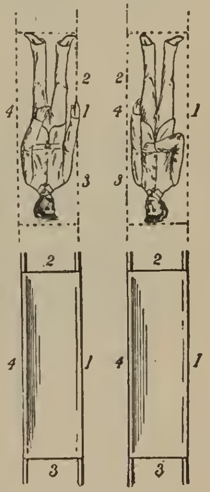

Fig. 149. — Relations in standing to patient, right and left, with the litter at the patient's head.

TO LOAD THE LITTER.

64. The litters being lifted (par. 57), or at a carry (pars. 27, 46), at the commands:

Take post to load, MARCH,

each chief assumes entire charge of his squad, and proceeds independently. The squad advances towards its assigned patient, and halts one yard from his head or feet, preferably his head, and in a line with his body. The litter is now opened (if it has been carried closed, as is the rule in field service — par. 50), and lowered.

65. The chief of squad then commands:

Stand to patient, right (or *left*), MARCH.

66. With litter at the head of the patient, if the command is right, Nos. 2, 1, and 3, proceeding by the right, take po-

sition, No. 2 at the right knee, No. 1 at the right hip, and No 3 at the right shoulder; while No. 4, passing by the left, takes position by the left hip opposite No. 1, all facing the patient.

67. If the command is left, Nos. 2, 4, and 3, proceeding by the left, take position, No. 2 at the left knee, No. 4 at the left hip, and No. 3 at the left shoulder; while No. 1, passing by the right, takes position by the right hip opposite No. 4, all facing the patient.

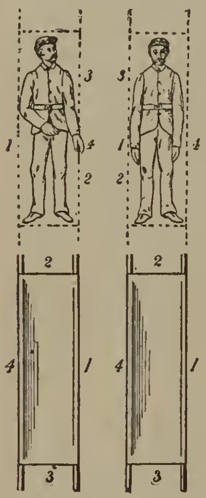

Fig. 150. — Relations in standing to patient, right and left, with the litter at the patient's feet.

68. Should the litter be placed at the feet of the patient, Nos. 1 and 4 cross each other on their way to their respective sides of the patient.

69. It will be seen from the above that, whether the command is right or left, the positions of Nos. 1 and 4 are invariable, No. 1 at the right hip, No. 4 at the left hip; and that the positions of Nos. 2 and 3 are always at the knee and shoulder, respectively, on the right or left of the patient, as the command may be; if right, they are on each side of No. 1; if left, they are on each side of No. 4.

70. In field service, Nos. 1 and 4 should run ahead and take position at the hip on their respective sides; they remove the arms and accoutrements of the wounded man, and examine him to determine the site and nature of the injury; and having administered restoratives, if required, and applied such dressings or splints as are needful or available, — in which duty all the members of the squad may be made use of, — the chief of squad commands: *Stand to patient*, etc. (par. 65).

71. As a rule, the command should be right or left, according as the right or left side of the patient is injured, so that by having the three bearers on that side a better support may be given to the wounded parts.

72. *Prepare to Lift.*

At this command all the bearers kneel on the right knee if on the right of the patient, and on the left knee if on his left. No. 2 passes both arms under the patient's legs, carefully supporting the fracture if there be one. Nos. 1 and 4 pass their arms under his hips and thighs side by side, not locking hands. No. 3 passes one arm under his neck to the further armpit, with the other supporting the nearer shoulder.

73. LIFT.

At this command all lift together slowly and carefully, and place the patient upon their knees. As soon as the patient is firmly supported there, the bearer on the free side (No. 1 or 4) relinquishes his hold, passes quickly and by the shortest

Fig. 151. — Lift.

line to the litter, which he takes up by the middle, one pole in each hand, and returning rapidly places it under the patient and against the bearers' ankles.

74. *Lower*, PATIENT.

The free bearer, No. 1 or 4, stoops and assists the other members in gently and carefully lowering the patient upon the litter. The bearers then rise and at once resume their positions at litter posts (par. 52).

75. In the field when the ground on which the patient lies is such that the litter cannot be placed directly under him, it

should be placed as near to him as possible and preferably in a direction parallel to or in a line with the body.

76. It may sometimes be necessary to carry the patient to the litter instead of the litter to the patient. The bearers having secured their hold, as before described (par. 72),

Fig. 152. — Placing the patient on the litter after carrying him to it.

rise together and move slowly and steadily to the litter. If the distance be great, it will be best for Nos. 1 and 4 to interlock fingers, palms up.

POSITION OF PATIENT ON THE LITTER.

77. The position of a patient on the litter depends on the character of his injury. An overcoat, blanket, blanket-bag, knapsack, or other suitable and convenient article, should be used as a pillow to give support and a slightly raised position to the head. If the patient is faint, the head should be kept

low. Difficulty of breathing in wounds of the chest is relieved by a sufficient padding underneath. In wounds of the abdomen, the best position is on the injured side, or on the back if the front of the abdomen is wounded; the legs in either case being drawn up, and a pillow or other available object placed under the knees to keep them bent.

78. In an injury of the upper extremity, calling for litter transportation, the best position is on the back with the injured arm laid over the body, or suitably placed by its side, or on the uninjured side, with the wounded arm laid over the body; while in injuries of the lower extremity the patient should be on his back, or inclining toward the wounded side. In cases of fracture of either lower extremity, if a splint cannot be applied, it is always well to bind both limbs together.

TO CHANGE BEARERS.

79. The litter having been brought to a halt and lowered, the order is given:

Change posts, MARCH,

when Nos. 1 and 4 relieve the bearers, as in par. 41.

80. The position of the men under this order holds good until posts are again changed, except in the case of such a disarrangement of the squad as calls for their reformation by the command: *At litter*, POSTS, when all take position in accordance with the requirements of par. 52.

GENERAL DIRECTIONS.

81. In moving the patient either with or without litter, every movement should be made without haste and as gently as possible, having special care not to jar the injured part. The command: *Steady*, will be used to prevent undue haste or other irregular movements.

82. The loaded litter should never be raised nor lowered without orders.

83. The rear bearer should watch the movements of the front bearer, and time his own by them, so as to insure ease and steadiness of action.

84. The number of steps per minute will depend on the weight carried, and other conditions affecting each individual case.

85. The handles of the litter should be held in the hands supported by the slings at arms-length, and only under the most exceptional conditions should the handles be supported on the shoulders.

86. The bearers should keep the litter level, notwithstanding any unevenness of the ground.

87. In making ascents the rear handles should be raised to bring the litter to the proper level; and if the ascent is steep, No. 1 should come to the assistance of No. 3 in raising it to the shoulder, if necessary.

88. In making descents the front handles should be raised, and if the descent is steep No. 4 should aid No. 2 in raising them.

89. As a rule, the patient should be carried on the litter feet foremost; but in going up hill, his head should be in front. In case of fracture of the lower extremities, he is carried up hill feet foremost and down hill head foremost to prevent the weight of the body from pressing down on the injured part.

90. For purposes of drill, a tag of red or white cotton or flannel may be attached to dummy wounded, to indicate the site and character of the injuries to be cared for.

TO PASS OBSTACLES.

91. A breach should be made in a fence or wall for the passage of the litter, if there be no gate or other opening; but should it be necessary to surmount the obstacle, Nos. 4 and 1 take hold of the poles each on his own side, thus permitting No. 2 to get over, when the front handles are passed to him; Nos. 4 and 1 then follow, and taking hold near the rear handles support the litter until No. 3 has crossed. All then resume their positions and continue the march.

92. The passage of a deep cut or ditch is effected in a similar manner; Nos. 1 and 4 bestride or descend into the cut and support the litter near its front handles until No. 2 has crossed and resumed his hold, when they then give support near the rear handles until No. 3 has crossed.

93. If the cut or ditch be wide, the litter is halted and lowered with the front handles (or feet) near the edge; Nos. 4 and 2 descend and advance the litter, keeping it level until the rear handles (or feet) rest upon the edge, when Nos. 3 and 1, who have assisted in this movement, descend and resume the support of their respective handles; the ascent on the other side is made by Nos. 4 and 2 resting their handles on the edge, ascending and advancing the litter until its rear handles rest upon the edge, when 3 and 1 ascend, and the march is resumed.

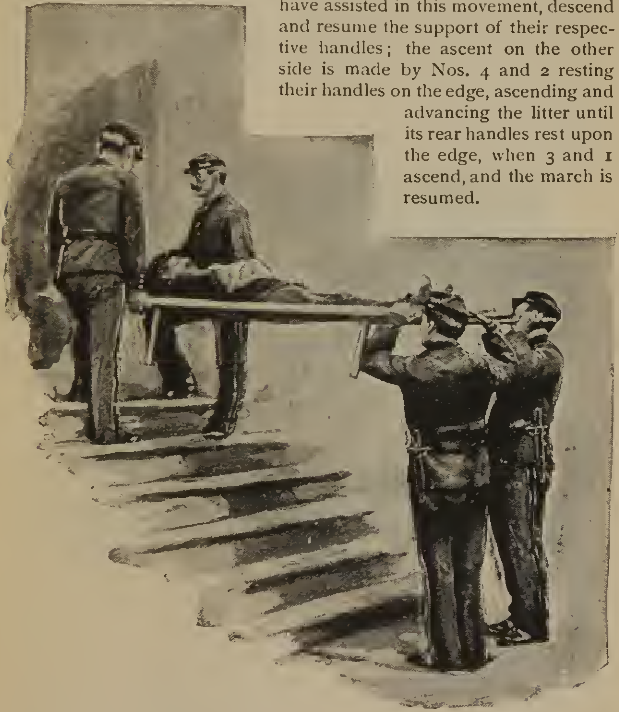

Fig. 153. — By four, carry litter, — used in carrying a patient upstairs.

94. In crossing a running stream or broken or otherwise difficult ground, Nos. 1 and 4 give support on their respective sides of the litter, or take full care each of the handle of his own side, — No. 4 in front, No. 1 in rear. In the latter case, the commands would be: *By four*, CARRY LITTER.

TO LOAD WITH REDUCED NUMBERS.

95. Should only three bearers be available, the litter is placed as usual at the head of the patient; Nos. 2 and 3 proceed to their proper positions at the knee and shoulder of one side, while No. 1 stands at the hip of the opposite side. The patient, having been lifted by the three bearers, is supported on the knees of Nos. 2 and 3, while No. 1 places the litter in position under him.

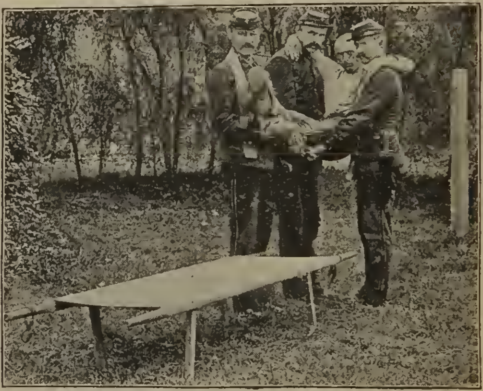

Fig. 154. — Carrying the patient to the litter, with but three bearers.

96. Another method for three bearers, when it is necessary to carry the patient to the litter, is as follows:

Nos. 2 and 3 take position opposite the knee and hip respectively, while No. 1 stands by the hip opposite No. 3. As with four bearers, Nos. 2 and 3 should preferably be directed to the wounded side. At the usual commands, Nos. 1 and 3 stoop and, raising the patient to a sitting position, place each one arm and hand around the back, and interlock the fingers of the other hand, palms up, under the upper part of the thighs. The patient, if able, clasps his arms around their

necks. No. 2 supports the lower extremities with both arms passed under them, one above, the other below, the knee.

97. If only two bearers are available (Nos. 2 and 3), the patient is necessarily always carried to the litter; No. 2 proceeds by the right and No. 3 by the left, and take position on opposite sides of the patient near his hips. They lift patient as directed (par. 96) for Nos. 1 and 3, the legs remaining unsupported, and carry him head foremost over the near end and length of the litter.

98. In case of a fractured lower extremity, the two bearers must take hold of the patient on the injured side, No. 2 supporting both lower extremities, while No. 3 supports the body, the patient clasping his arms around his neck.

TO UNLOAD THE LITTER.

99. To unload with four or three men, they *stand to patient* as in loading; at the commands: *Prepare to lift*, LIFT, they raise him upon the knees, the free bearer removes the litter, and at *Lower*, PATIENT, they lower him carefully to the ground.

100. With two men, they form a two-handed seat and lift the patient off the litter; or, in case of fracture, they stand on the same side and, stooping, lift him and take two steps backward to clear the litter, when they lower him to the ground.

TO TRANSFER PATIENT FROM LITTER TO BED OR ANOTHER LITTER.

101. With four men, the litter being placed close alongside the bed (on either side), the patient's head corresponding to that of the bed, he is taken from the litter and supported on the knees in the usual manner. The free bearer then removes the litter, and the others having risen take a step forward and lower the patient upon the bed.

102. With three men, the litter is placed at the foot of the bed, and in line with it; the three bearers, all on one side, lift the patient without kneeling, and move cautiously by side steps to the bedside.

103. With two men, the litter is placed at the foot of the bed as before, and the patient carried cautiously by side steps, or carried head foremost over the foot of the bed on a two-handed seat.

IMPROVISATION OF LITTERS.

104. Many objects can be used for this purpose:

Fig. 155. — Litter of two poles thrust through two grain sacks.

Camp cots, window blinds, doors, benches, boards, ladders, etc., properly padded.

Litters may be made with sacks or bags of any description,

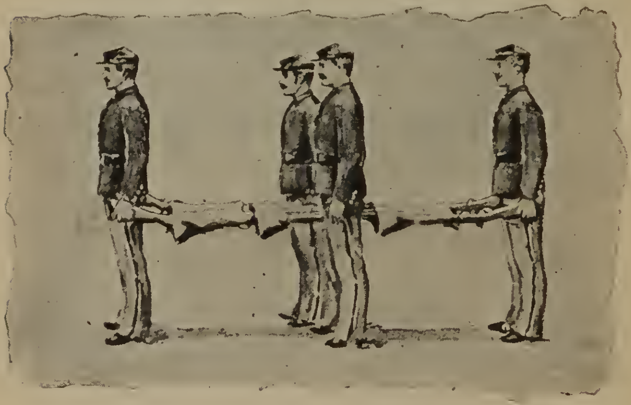

Fig. 156. — Litter of three coats and four rifles.

if large and strong enough, by ripping the bottoms and passing two poles through them, and tying cross pieces to the poles

to keep them apart; two, or even three, sacks placed end to end on the same poles may be necessary to make a safe and comfortable litter.

Bedticks are used in the same way by slipping the poles through holes made by snipping off the four corners.

Pieces of matting, rug, or carpet trimmed into shape may be fastened to poles by tacks or twine.

Fig. 157. — Litter formed by a single pole and a hammock.

Straw mats, leafy twigs, weeds, hay, straw, etc., covered or not with a blanket, will make a good bottom over a framework of poles and cross sticks.

Better still is a litter with bottom of ropes or raw-hide strips, whose turns cross each other at close intervals.

105. But the usual military improvisation is by means of two rifles and a blanket.

One-half of the blanket is rolled lengthwise into a cylinder, which is placed along the back of the patient, who has been turned carefully on his side. The patient is then turned over on to the blanket and the cylinder unrolled on the other

side. The rifles (with bayonets fixed, if at hand) are then laid on the ground under the side edges of the blanket, muzzles to the front and somewhat converging, butts to the rear or head of the patient, and are rolled tightly in the blanket, each a like number of rolls, until the side of the body of the patient is reached, when they are turned hammers downward.

Two bearers may carry the wounded man in this improvisation, but it is better, whenever possible, that four men should do so — two on each side, firmly grasping the blanket, over the rifle.

METHODS OF REMOVING WOUNDED WITHOUT LITTERS.

FOR ONE BEARER.

106. While it is not desirable that one bearer should, ordinarily, be required or permitted to lift a patient unassisted, emergencies may arise when a knowledge of proper methods of lifting and carrying by one bearer is of the utmost value.

Fig. 158. — Lifting the patient from the ground.

107. A single bearer may carry a patient in his arms; on his back, or across his shoulder.

To bring the patient into any of these positions, the first steps are as follows:

The bearer, turning patient on his face, steps astride body, facing toward the head, and with hands in his armpits lifts him to his knees, then clasping hands over the abdomen, lifts him to his feet and places the patient's left

arm around his (the bearer's) neck, the patient's left side resting against his body.

108. From this position the bearer proceeds as follows:

Fig. 159. — Preliminary position, the same in all cases.

To lift the patient in his arms:

The bearer, with his right arm behind patient's back, passes his left under thighs and lifts him into position.

109. *To place patient astride of back:*

The bearer shifts himself to the front of patient, back to him, stoops, and grasping his legs above the knees brings him well up on his back.

Fig. 160. — Carrying patient astride of back.

110. *To place patient across back:*

The bearer with his left hand seizes the left arm of the patient and draws it down upon his left shoulder, then, shifting himself in front, stoops and clasps the right thigh with his right arm passed between the legs, when he rises.

Fig. 161. — Carrying patient across shoulder.

111. *To place patient across shoulder:*

The bearer faces patient, stoops, places his right shoulder against the abdomen, and clasps the right thigh with the right arm passed between the legs; he then grasps the patient's right hand with his left, and draws the right arm down upon his left shoulder until the wrist is seized by his own right hand; lastly, he, with his left hand, grasps the patient's left and steadies it against his side, when he rises.

112. In lowering patient from these positions the motions are reversed. Should a patient be wounded in such manner as to require these motions to be conducted from his right side, instead of left as laid down, the change is simply one of hands — the motions proceed as directed, substituting right for left, and *vice versa*.

Fig. 162. — Two-handed seat.

FOR TWO BEARERS.

By the two-handed seat:

113. The patient lying on the ground, at the command:

Form two-handed seat,

the two bearers take position facing each other, No. 1 on the right and

No. 2 on the left of the patient, near his hips. At the command:

Prepare to lift,

they raise the patient to a sitting posture, pass each one hand and arm around his back, while the other hands are passed under the thighs, palms up, and the fingers interlocked. At the command:

LIFT,

both rise together. If the patient has to be so carried for a long distance, the bearers should grasp each other's wrists under the patient's thighs. In marching the bearers should break step, the right bearer starting with the right foot and the left bearer with the left foot.

NOTE. — A method, which is of particular value because of the ease with which the bearer may preserve his equilibrium and because it leaves one hand free for use in climbing ladders, carrying arms, etc., is as follows:

Fig. 163. — Lifting over the shoulder.

Fig. 164. — Carrying patient over shoulder

To place patient over shoulder.

From the preliminary position, the bearer passes his right hand between the patient's thighs and, turning to face the patient, places his right shoulder against the patient's abdomen, permitting the patient to fall over his right shoulder (Fig. 162), and, with his right hand, grasping the patient's right hand — which has been drawn under his left armpit — rises to his feet (Fig. 163). — *Author.*

By the four-handed seat:

114. This method is applicable when the patient has considerable strength and the use of his arms. At the command:

Fig. 165. — Four-handed seat.

Form four-handed seat,

the two bearers take position as in par. 113. At *Prepare to lift* they stoop, pass their hands under the patient's buttocks and form a four-handed seat, each bearer grasping his right forearm just above the wrist with the left hand, and then grasping the other bearer's disengaged forearm with his own disengaged hand, palms down. At the command LIFT, both rise together, the patient steadying himself by passing his arms around the bearers' necks.[1]

By the extremities:

115. This method requires no effort on the part of the patient; but it is not applicable to severe injuries of the lower extremities. One bearer stands by the patient's head, the other between his legs, both facing toward the feet. At *Prepare to lift*, the rear bearer clasps the wounded man around the

Fig. 166. The three-handed seat

[1] NOTE. — A seat frequently used — the three-handed seat — is a modification of the four-handed seat and is formed in a very similar manner, the left-hand bearer grasping his own right forearm with his left hand and the other bearer's right forearm with his right hand; the right-hand bearer grasps the other bearer's right shoulder with the left hand and his left forearm with the right hand (Fig. 166). In this way a seat is formed with a back. *Author.*

body under the arms, while the front bearer passes his arms from the outside under the flexed knees. At LIFT both bearers rise together.

By the rifle seat:

Fig. 167. — Carriage by the extremities.

116. A good seat may be made by running the barrels of two rifles through the sleeves of an overcoat, so that the coat lies back up, collar to the rear. The front bearer rolls the tails tightly around the barrels and takes his grasp over them; the rear bearer holds by the butts, hammers down.

117. A stronger seat is secured when the gun-slings are used. The slings are unhooked and let out to their full length from the rear swivel. The rifles are then placed upon the ground, parallel to each other, but with the hammers outside, at a distance of about 20 inches. Each sling is passed around the opposite rifle, then around its own, and lastly hooked to the front swivel of the other rifle, thus forming a seat 20 inches wide and 2 feet long, on which the patient sits with his back against the rear bearer, his legs hanging over outside, and the hollow of his knees resting upon the barrels.

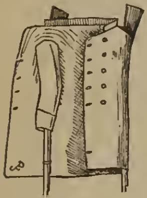

Fig. 168. — Litter of rifles and overcoat.

118. A quicker way to prepare a rifle seat, when a twist of the slings is not objectionable, is as follows:[1]

Two men with the slings of their rifles loosened, as for carrying on the back, face each other and bring their pieces to a "present arms." Thereupon No. 1 seizes the sling of

[1] Method of Captain Norton Strong, U.S.A.

No. 2's rifle with the right hand, lifts his own rifle with the left hand, and passes the butt through the sling from left to right, straightening the piece as soon as the hammer has cleared the sling. No. 2 grasps the sling of No. 1's rifle with the right hand, and, depressing the muzzle of his own piece, passes it through the sling he holds, from left to right, straightening the piece as the sling is cleared.

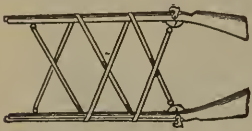

Fig. 169.—The rifle seat.

The pieces now being at the original "present," the butts are lowered to the ground, the left hand of each man being brought to the muzzle of his gun. No. 2 grasps the muzzles, No. 1 stoops and secures the butts.

FOR THREE BEARERS.

119. See paragraphs 95 and 96.

TO PLACE A SICK OR WOUNDED MAN ON HORSEBACK.

120. In emergencies it may be needful to carry a disabled man on horseback. The help required to mount him will depend on the site and nature of his injuries; in many cases he is able to help himself materially. If he be entirely helpless, five men are required to get him into the saddle — one to hold the horse, the others to act as bearers.

The horse, blind-folded, is held in position at right angles to the patient, who lies on the ground on his back on the near side, with his head toward the horse. Nos. 2, 1, and 4 take position as at *stand to patient, left*, No. 2 at the ankles on the left, and the others at the right and left hip respectively, while No. 3 stands on the off side of the horse ready to grasp the shoulders of the patient when they are brought within his reach. At *Prepare to lift*, No. 2 passes both arms under the legs; 1 and 4 place each hand under the corresponding buttock and the other under the shoulders, not locking hands. At LIFT, the patient is carefully raised

and carried over the horse until his seat reaches the saddle. No. 1 now goes quickly around the horse's head to the off side, and the patient is made to pivot in the saddle, Nos. 3 and 4 on either side supporting and at the same time depressing his back, while No. 2 raises the legs until the right leg comes within reach of No. 1, when each foot is carried downward for support in its stirrup.

121. To dismount, the process is reversed: Nos. 3 and 4 standing on each side of the horse depress the body of the

Fig. 170. — Placing an injured man on horseback.

patient backward, while 1 and 2 raise the legs. The patient is then pivoted to the left, No. 1 passing the right leg over the pommel to No. 2 and then taking position on the near side to lower the patient to the ground or litter, as the case may be.

122. *To mount with the assistance of three men:* The three bearers take position by the patient, as above, on the near side of the horse and raise him into the saddle, when, if the legs are not injured, No. 2 relinquishes them to take post on the off side and aid No. 1 in adjusting them; but if the legs are injured, No. 1 should take post on the off side to aid No. 2 in this part of the work, the other member of the squad meanwhile supporting the body in the saddle.

123. *With only two bearers* it is possible, but difficult, to place a helpless man on horseback: The patient having been raised into the saddle by both bearers, one of them goes to the off side to aid in effecting his adjustment.

124. The patient once mounted should be made as safe and comfortable as possible. A comrade may be mounted behind him to hold him and guide the horse; otherwise, a lean-back must be provided, made of a blanket roll, a pillow, or a bag filled with leaves or grass. If the patient be very weak, the lean-back can be made of a sapling bent into an arch over the cantle of the saddle, its ends securely fastened, or of some other framework to which the patient is bound.

THE TRAVOIS.

125. The travois consists of a litter drawn by one animal, the rear handles trailing on the ground. It is the ordinary

Fig. 171. — The travois.

Indian conveyance for patients and baggage, and being such, may be considered the best method of improvising means of transport in our western country The travois requires only one animal and two men, one to lead the animal, the other to watch the litter and be ready to lift its rear poles when passing over obstacles, crossing streams, or going up hill.

It may be improvised by cutting poles 15 feet long and about 2 inches in diameter at the small end. These poles are laid parallel to each other, small ends to the front and 2½

feet apart; the large ends about 3 feet apart, and one of them projecting 8 or 10 inches beyond the other. The poles are connected by a crossbar about 6 feet from the front ends of the poles, and another about $2\frac{1}{2}$ feet from the rear ends, each notched at its ends and securely lashed by its notches to the poles. Between the cross-pieces the litter-bed, $6\frac{1}{2}$ feet long, is filled in with canvas, blanket, etc., securely fastened to the poles and crossbars, or with rope, lariat, rawhide strips, etc., stretching obliquely from pole to pole in many turns crossing each other to form the basis for a light mattress or improvised bed; or a litter may be made fast between the poles to answer the same purpose. The front ends of the poles are then securely fastened to the saddle of the animal.

THE TWO-HORSE LITTER.

126. The *two-horse litter* consists of a litter with long handles used as shafts for carriage by two horses, or mules,

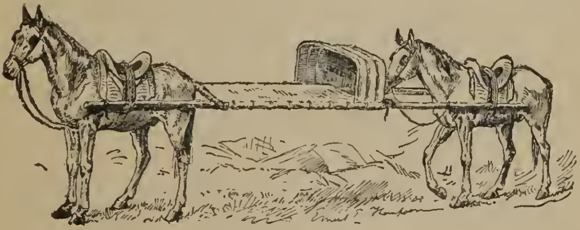

Fig. 172. — Two-horse litter.

one in front, the other in rear of the litter. It accommodates one recumbent patient. On a good trail it is preferable to the travois, as the patient lies in the horizontal position, and, in case of fractured limbs, they can easily be secured against disturbance. The great disadvantage of this litter is that it requires two animals and three men for the carriage of each patient, one to attend to the disabled man, and the others to watch over and guide the movements of the animals. This

litter may be improvised in the same manner as the travois, only the poles should be 16½ feet long, and the crossbars forming the ends of the litter-bed should be fastened 5 feet from the front and rear ends of the poles. The ends are made fast to the saddles by notches, into which the fastening ropes are securely tied.

AMBULANCE DRILL.

127. The regulation ambulance provides transportation for eight men sitting, or two lying. As prepared for the road it should contain two closed litters beneath the seats, with spare litters outside, and four seats for two occupants apiece.

128. The litters are said to be *packed* when they are closed and placed beneath the seats, canvas up. The seats are said to be *prepared* when they are horizontal with the leg-irons resting on the floor-plates; and *packed* when they are hooked against the sides of the wagon.

129. *To take posts at the ambulance*, the squad is marched to the ambulance preferably by columns of files, and when within a short distance of it the commands are given:

At ambulance, POSTS,

when No. 1 takes post on the left, No. 2 in the centre, and No. 3 on the right of the rear of the ambulance and close to it, No. 4 on the right of No. 3.

130. This is the invariable position of the squad *at ambulance, posts*; and when disarranged, from whatever cause, it may be reassembled by these commands for service at the ambulance.

TO PREPARE SEATS.

131. The ambulance having litters and seats packed, *to prepare seats:*

The ambulance being at a halt and the squad at ambulance posts, the commands are given:

Prepare, SEATS.

Nos. 1 and 3 raise the curtain if necessary and open the tail-gate: Nos. 2 and 3 enter the ambulance, No. 2 facing the

front, and No. 3 the rear seat of their respective sides. Each man seizes the lower edge of the seat about six inches from the ends with both hands, and lifts it carefully to free the hooks from the upper slots, and then slips them into the lower slots; he raises the legs and adjusts them to the seat which he tries for firmness before leaving it. He then prepares in like manner the other seat of his side.

132. When the seats are prepared, No. 2 leaves the ambulance, but No. 3 remains, unless otherwise directed, until he has stowed such baggage as may be passed to him by the other bearers; they now resume their places at ambulance posts.

TO PACK SEATS.

133. The ambulance being at a halt and the squad at ambulance posts, the commands are:

Pack, SEATS.

Nos. 1 and 3 raise the curtain, open the tail-gate, and each removes the litter on his own side, laying it on the ground two yards in rear; Nos. 2 and 3 enter the ambulance, No. 2 facing the front, and No. 3 the rear seat of their respective sides. Each man holds the seat with one hand and folds the leg-irons with the other; then seizing the front of the seat with both hands, he raises the seat to clear the hooks from the lower slots and slips them into the upper slots. He then packs in like manner the other seat of his side.

134. As soon as the seats are packed the bearers resume their places at ambulance posts.

135. Should it be necessary to pack seats while the ambulance is in motion, the tail-gate is opened, Nos. 2 and 3 enter, pass out the litters to Nos. 1 and 4, respectively, and pack the seats as described.

TO LOAD THE AMBULANCE.

136. The litter being lifted, at the commands:

Take post to load ambulance, MARCH,

the squad proceeds to the ambulance, and when one yard

from the rear step, halts and faces the litter about, so that the head of the patient is towards the rear of the ambulance, and then lower it.

137. At the command:

Prepare to load,

Nos. 2 and 3 face about (toward the ambulance) and Nos. 1 and 4 face the litter; No. 3 steps outside of his right

Fig 173. — Loading the ambulance.

handle and faces the litter. No. 2 remains between the rear handles, and No. 1 takes post outside the left handle opposite No. 3 and facing him, while No. 4 opens the tail-gate and sees that the ambulance is in suitable condition for the reception of the patient. If he requires assistance, No. 1 should render it.

At the command:

LOAD,

the three bearers, Nos. 1, 2, and 3, stoop, grasp their respective handles, and slowly raise the litter to the level of the floor of the ambulance and advance to it, being careful to

keep the litter in a horizontal position; the legs are placed on the floor by Nos. 1 and 3 and the litter pushed in by No. 2, assisted by the others. When this is accomplished, Nos. 1, 2, and 3 are in position at ambulance posts, No. 1 on the left, No. 2 in the centre, and No. 3 on the right, facing the rear of the ambulance and close to it. Nos. 1 and 3 fasten the tail-gate; No. 4 places in the forward compartment the arms and accoutrements of the patient (if any) and then takes his position on the right. After this No. 1, having seen that everything is secure, faces the men about and marches them off to continue the drill by bringing up another loaded litter, returning to unload, etc.

TO UNLOAD THE AMBULANCE.

138. The squad having been brought to ambulance posts, the order is given:

Prepare to unload,

when Nos. 1 and 3 open the tail-gate and No. 2 lays hold of the projecting handles. At the command:

UNLOAD,

No. 2 draws out the litter. Nos. 1 and 3, facing inward, support the poles until the front handles are reached. The litter, carefully supported in a horizontal position, is then lowered with the head of the patient one yard in rear of the wagon; No. 4 closes the tail-gate, and all take position at litter-posts. The litter is then lifted and carried in the required direction.

139. At the conclusion of the drill with ambulances the detachment is reformed in line of litters as in par. 63.

Part IV

THE CARE OF THE HUMAN MACHINE

CHAPTER XXIX

SANITARY SUGGESTIONS

THE human body resembles other machines in requiring proper care to maintain it in good order. It must be suitably housed and protected, the effects of wear and tear must be removed and harmful extraneous matters must not be permitted to reach it, it must be kept clean and sufficient power-producing matter or fuel must be provided for it.

Dwellings. — For privacy and protection, man is accustomed to build for himself shelters varying in extent from the wickyup of the savage to the palace of the prince. By so doing he introduces a fruitful source of disease. The confinement of the air within the walls of a dwelling compels it to be breathed repeatedly until, by the extraction of all of its nourishing elements and the pollution derived from the emanations of living bodies, it is not only no longer capable of supporting life, but is a direct cause of death. The process of supplying fresh air to dwellings is called ventilation.

Ventilation. — The reasons for the necessity of an abundant supply of fresh air have already been considered (pages 69 and 70). Ventilation is usually accomplished by the flow of air in and out of doors and windows. More than seven per cent of carbonic acid in the air is injurious, and rooms should be of a sufficient size to permit the constant introduction of enough fresh air and the prompt removal of enough contaminated air to keep the percentage continually below this point without the production of a draught. This can be accomplished by limiting the number of well persons in a room to such a degree that each one shall have about 800 cubic feet of air-space, or a portion measuring nine feet in each direction; in this case the entire bulk of air would need to be renewed but once in twenty minutes, which can readily

be accomplished by the ordinary means of doors and windows. In case of the sick, the requisite air space is double the amount named.

The presence of foul air in dwellings — whether due to the breath of persons crowding a room or to other causes — is a fertile source of certain diseases, such as consumption, malarial affections, typhoid and typhus fevers, and the like. For this reason homes should not only be provided with proper ventilation, but swampy surroundings, foul cellars, cesspools or pools formed by accumulations of slops, uncared-for water-closets, and sewer openings should be avoided as far as practicable and, when existing, should be rendered as harmless as possible by disinfection.

Disinfection. — Certain agents, when applied to disease-inducing matters, destroy their power. These agents are *disinfectants*, and the process of applying them is disinfection.

The term disinfectant has popularly been applied to agents which counteract offensive odors — deodorizers — or arrest decay — antiseptics. This is an error, for many of these agents are entirely without effect upon disease germs. A large number of the proprietory "disinfectants" advertised in the public press are of this character.

The more valuable agents for disinfection are four in number:

1. *Heat.* — A temperature elevated to the boiling-point or higher is the most efficient of disinfectants; it is also a deodorizer and an antiseptic. Boiling for half an hour destroys germs of the greatest vitality. Infected materials, which will not be harmed by it, may be treated either in this way or by the application of superheated steam.

2. *Corrosive Sublimate.* — Known also as bichloride of mercury, this is the most powerful chemical germicide, and consequently, for purposes where heat is not practicable, the most efficient germicide known.

> *For Disinfection of Clothing.* — Four ounces should be dissolved in a gallon of water, with one drachm of permanganate of potassium. The clothing must be thoroughly soaked in this solution for at least two hours, after which it may be laundered in the ordinary way.

For Disinfection of Other Infectious Matter. — Two drachms each of corrosive sublimate and permanganate of potassium should be dissolved in a gallon of water.

3. *Chloride of Lime.* — Popularly known as "bleaching powder," this agent is especially useful in disinfecting the discharges from the body or foul soil of any kind. It is also a deodorant.

For Ordinary Disinfection. — One part of chloride of lime with nine parts of dry earth is an excellent disinfectant sprinkled copiously into privy vaults, cesspools, etc.

For Disinfection of Infectious Matter. — Four ounces of chloride of lime dissolved in a gallon of water form a solution into which should be passed the discharges from cholera, typhoid fever, and other affections having discharges of an infectious character.

4. **Sulphur.** — Sulphur may be used in the form of roll sulphur or brimstone or cast into sulphur candles. The disinfecting element is sulphurous acid gas, which is liberated by burning. To get the effect of this agent, every aperture in a room must be tightly closed to prevent its escape, and three pounds of sulphur used for every thousand cubic feet of air-space. The sulphur should be broken into small pieces and moistened with alcohol before lighting. To obviate the danger of fire, it should be placed in a shallow iron pan set upon a couple of bricks in a tub partly full of water. After twenty-four hours the doors and windows should be thrown wide open to permit the sulphurous acid gas to be blown out.

The stools in cholera and typhoid fever, and probably in epidemic dysentery, consumption, diphtheria, and yellow, scarlet, and typhus fevers are infectious. The vomited matter in cholera, diphtheria, and yellow and scarlet fevers is liable to convey infection; and the expectoration of consumption, diphtheria, scarlet fever, and infectious pneumonia is similarly dangerous. They should all then be discharged into vessels containing enough corrosive sublimate or chloride of lime solution to cover them.

Clothing contaminated by small-pox, scarlet fever, and other contagious diseases may be disinfected by immediately boiling it or by soaking it in a corrosive sublimate solution. But clothing and bedding

too bulky, or otherwise unsuited to such treatment, should be burned without delay.

During the occupation of a room by a subject of infectious disease it cannot be disinfected except by free ventilation, — removing the contaminated and introducing fresh air. To render this easier, the carpets, pictures, hangings, and all unnecessary furniture should be removed when the room is given to the patient.

After the removal from a room, by death or recovery, of a subject of infectious disease, the walls, ceiling, and floor should be washed with a solution formed by the addition of a pint of the stronger corrosive sublimate solution to four gallons of water. All woodwork should be scrubbed with soap and water. After this the room may also be fumigated with sulphur.

Centres of putrefaction, such as cesspools, drains, and privy vaults may be treated with the weaker sublimate solution, or with chloride of lime in solution, or in powder, as may be convenient.

Food and drink are readily and infallibly disinfected by cooking. Boiling or roasting for half an hour destroys the most active germs. In case of an epidemic of cholera or typhoid fever, nothing should be taken into the stomach that has not been so treated.

Deodorization. — As already remarked, certain agents are of value in overcoming offensive odors, although not useful as disinfectants.

Dry earth, wood ashes, and powdered charcoal belong to this class, and are to be applied by free sprinkling.

Chloride of zinc, an ounce dissolved in a quart of water, is an effective deodorant.

Chloride of lime, in solution and in powder, belongs to both classes.

Cleanliness. — Nothing is a more efficient preventive of sickness than cleanliness of person, habitation, and surroundings. Filth of every kind is a most favorable soil for the culture of disease. The surroundings of a dwelling, then, should be carefully cleaned, no piles of decaying matter — either vegetable or animal — being permitted. That the house itself should be kept clean goes without saying.

The skin throws off every day two or three pounds of excrementitious matters, both solid and liquid, and to insure its proper action, they must be removed. If they are permitted to remain, decomposition soon sets in, and the skin is then

covered with a layer of decaying matter which closes the pores and paves the way for much ill-health. When practicable, then, the entire person should be bathed daily with fresh water, or, better, with a solution of an ounce of carbonate of soda to the gallon of water.

Clothing. — The prime object of clothing being the protection of the body from the harmful action of atmospheric heat, cold, and moisture, it follows that the clothing should be modified from time to time to suit the weather. The materials should vary in weight, texture, and character, according to the season and the latitude, since both extremes of bodily temperature are equally dangerous to health. The fit of the clothing is of importance, for ill-fitting clothing is apt to be chafing to the body as well as to the spirit.

Chafing occurs chiefly in the bends of the joints, such as the armpits, elbows, and knees, and between the thighs, but it may appear at any point where the clothing rubs the skin. The chafed parts should be carefully washed with soap and water and thoroughly dried; they may then be dusted with a suitable bland powder, such as magnesia, fuller's earth, and even starch, meal, or flour, although the latter are objectionable on account of their liability to form with the perspiration a sour and irritating paste.

Foot-soreness is chiefly due to ill-fitting shoes, although it may arise from other causes. It is a common complaint in marching. Soaking in hot salt water, or alum and water, the night before is said to reduce the liability to foot-soreness. Rubbing the feet with grease of any kind before starting is an advantage. In the German army there is sifted into the shoes and stockings, to prevent trouble with the feet, a powder composed of three parts by weight of salicylic acid, ten of starch, and eighty-seven of powdered soapstone. Blisters should be opened at the end of the march by pricking at either end and gently pressing the fluid out of the openings, taking care not to break the skin. Where the difficulty is due to inflamed corns, bunions, or ingrowing toenail, the surgeon should apply the treatment.

Food. — The food forms an important part of the fuel of the human machine. The more easy the digestion, — the process of extracting the portions of the fuel utilizable in the machine, — the more easily the machine runs. The following table, showing comparatively the time required for the digestion of some of the more common articles of diet, may serve as a guide to the selection of food for the body — fuel for the machine: —

Rice, Boiled; Tripe, Boiled	1 hour.	Beef, Roast; Mutton, Roast; Oysters; Eggs, Soft	3 hours.
Eggs, Uncooked; Tapioca; Barley or Sago; Milk, Boiled; Codfish	2 hours.	Bread; Butter; Cheese; Eggs, Hard; Eggs, Fried	3½ hours.
Turkey, Roast; Lamb, Roast; Beans; Potatoes	2½ hours.	Duck; Chicken	4 hours.
		Veal, Roast; Pork, Roast	4½ hours.

The amount of food required to maintain a healthful existence varies according to the individual and his occupation. Physiologists have carefully worked out the proportion of the various elements required for this purpose. The ration of the United States soldier, while not absolutely complete as a dietary, perhaps approaches as nearly the amount needed daily by a healthy man as may be required. It contains —

Fresh beef or other fresh meat	20 oz.
or Salt beef	22
or Salt pork or bacon, or canned beef	12
Potatoes	16
or Potatoes	12.8
and Onions	3.2
or Potatoes	11.2
and Tomatoes (or other vegetables in cans)	4.8
Sugar	2.4
Salt	.64

	Pepper	.04 oz.
	Flour	18
or	Soft bread	18
or	Hard bread	16
or	Corn meal	20
	Beans or peas	2.4
	Rice or hominy	1.6
	Coffee, green	1.6
or	Coffee, roasted	1.28
or	Tea	.32
	Vinegar	.04 qt.
	Soap	.48 oz.

Where illuminating oil is not furnished, .24 oz. candles; and in the field, when necessary, .48 oz. yeast powder.

Of equal if not greater importance than the amount of food is its proper preparation. As has been remarked in connection with the sense of taste, the rendering food savory and digestible, and serving it in a tempting manner, is a study worthy the attention of a higher grade of talent than is ordinarily devoted to it. Recent experiments by Edward Atkinson have shown that the art of cookery is still in its infancy. It is impossible, however, within the limits of this Manual to do more than to call attention to the deficiency and to urge a more general attention to the subject.

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